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ABSTRACT

This activity guide is based on the Public Broadcasting System's (PBS) program "ZOOM." It is designed for educators with activities that are categorized into three themes: (1) Things That Go, which includes "Air" which explores air pressure, "Rubber Bands" which discovers the potential energy of rubber bands, "Baking Soda and Vinegar" which demonstrates the chemical reaction power of carbon dioxide, and "Gravity" which creates a salt pendulum; (2) Things That Grow, featuring "Compost" which makes compost using table scraps, "Biodome" which creates a biodome and observes a miniature ecosystem, "Germinator" which grows plants by germinating seeds, and "Count and Observe" which gathers and analyzes data; and (3) Things You Build, which contains "Height" which builds a mobile to explore the impact of balance, "Protection" which makes a parachute to observe the relationship between surface area and speed, and "Strength" which builds a tower from drinking straws. (YDS)

sci™ activity guide

National Science Foundation
4201 Wilson Boulevard
Arlington, Virginia 22230

Dear Educator:

The National Science Foundation (NSF) is pleased to be a major sponsor of the PBS series, ZOOM. NSF supports educational initiatives across the country that help young people build skills in mathematics and science and support their interest in these subjects. ZOOM's substantive focus on math and science promotes children's curiosity about the world and develops life-long habits of mind in problem solving and inquiry. One of the most exciting things about ZOOM is that it encourages children to be active learners and participants in science: to ask questions, do the experiments from the show, and create their own ideas and activities.

We encourage you to use ZOOMsci Activity Guide, together with the series and other multimedia outreach components, as a way to help children to be active investigators and problem solvers. In doing so, you join thousands of others across the country in promoting children's interest in and knowledge of science and math.

Sincerely,

Hyman Field
Acting Division Director
Elementary, Secondary, and Informal Education
National Science Foundation

contents

ZOOM is back—with a new look! The hip show from the '70s that brought you Bernadette's wave and its own language, Ubbi Dubbi, gives a new generation of kids the chance to explore, experiment, and share their creativity with the world.

Produced by WGBH, Boston's public television station, ZOOM is a daily, interactive television series on PBS. *By kids for kids*, each show is jam-packed with games, videos, stories, experiments, recipes, and brainteasers—all sent in by viewers and performed by a cast of seven, everyday kids. ZOOM encourages an active, exploratory, hands-on, minds-on approach to all kinds of learning. The multi-disciplinary format is one of its greatest assets—not only does it attract children with different interests (including many who would not normally tune into a science or math show), but it may even awaken a curiosity about mathematics and science that would otherwise remain dormant.

ZOOM models and teaches science and math in a unique, completely kid-centered way. Each half-hour of ZOOM contains two science and math segments—called ZOOMsci™—which promote behaviors we call "Habits of Mind"—a skills-based and affective framework. These "Habits" include being curious, pursuing ideas, and looking for multiple solutions instead of a single right answer.

But ZOOM is more than just a TV show. It also includes a widespread multimedia outreach campaign designed to make ZOOM activities accessible to kids, parents, and educators. Kids can *zoom* to the Web site to find ideas for new activities and share their own results, visit interactive activity spaces called ZOOMzones™ in museums across the country, and receive ZOOMerang,™ a free newsletter full of ZOOM activities, whenever they communicate with ZOOM. To further extend the educational impact of the series, we have developed this ZOOMsci Activity Guide, a hands-on science and math curriculum, for use in afterschool programs and classrooms serving children aged six to eleven. We hope that you find the guide useful in engaging your students in science.

about ZOOM™

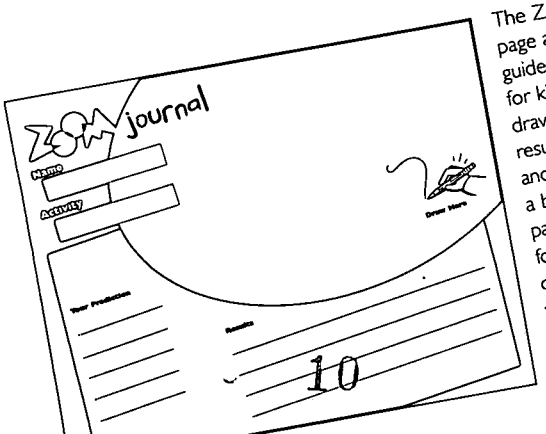
using this guide

ZOOMsci activities are interactive, hands-on, and, most of all, fun. They introduce science and math concepts by showing kids how science works in the real world and relates to their everyday lives. What's more, ZOOM activities are by kids for kids. So kids like doing them.

The ZOOMsci Activity Guide was designed for educators working in informal settings like afterschool programs, camps, and other youth programs. It helps you guide kids through a deeper, more rewarding exploration of the science in the activities on ZOOM. You can do the activities with or without the ZOOM show. And you don't have to be a scientist. You only have to share the kids' enthusiasm for and curiosity about the way things work in nature and in our world. Together, you can ask questions, speculate about the answers, experiment to see what works, observe what happens, and record data to develop an explanation. We've provided everything you need.

The guide focuses on three themes: *Things that Go, Things that Grow,* and *Things You Build.* Each theme has several three-page activity units. These units include two educator's pages with warm-up activities, preparation tips, and activity set up information. The units also include reproducible activity pages for your kids. Before doing the activity, it's important to read the "ZOOM Kid's Activity" page, since it contains instructions. You may also want to try the activity yourself. That way you'll be familiar with the process and can provide guidance.

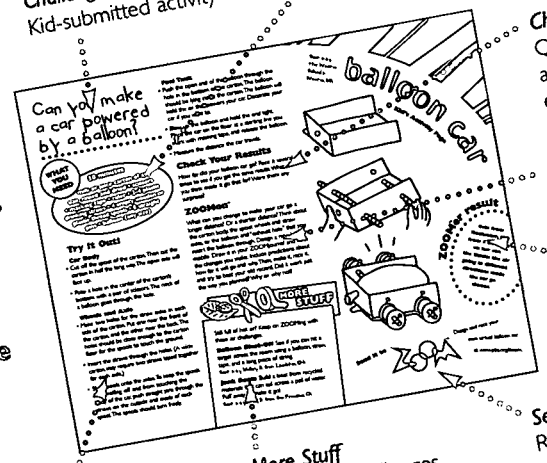
You can tape any ZOOM program and use it for up to one year after broadcast.



The ZOOMjournal™ page at the back of the guide provides a space for kids to record and draw their data and results. Copy the page and have your kids make a book. The educator pages include suggestions for its use and, of course, you can add your own.

Kid's Activity Page

This reproducible page helps kids do the activity.



Activity Title and Challenge to the Kids
Kid-submitted activity

What You Need
Activity materials and time needed

Check Your Results
Questions and additional ideas for exploring the science

ZOOMon™
Extension activities

ZOOMfact™ or ZOOMer result™
Interesting tidbits of information

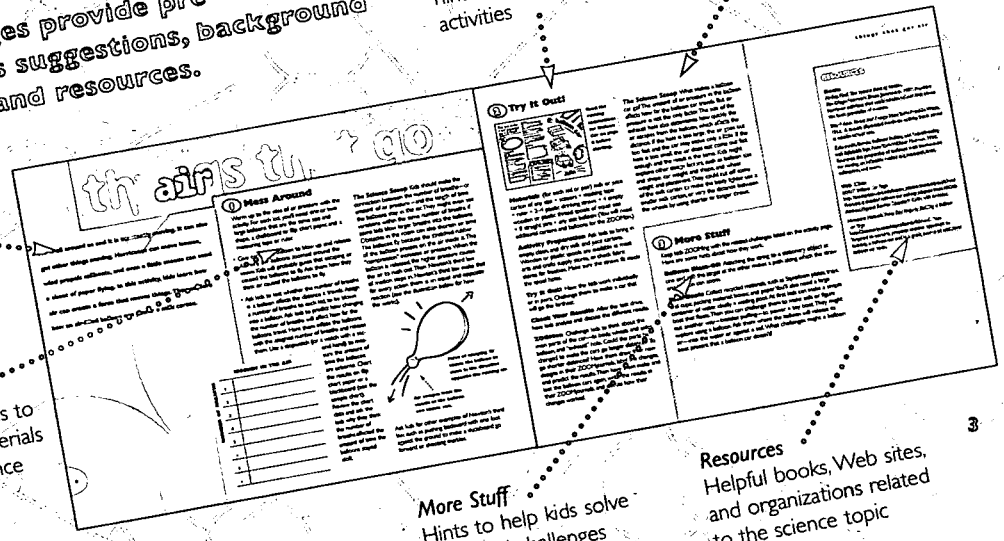
Send It to ZOOM
Request for submissions

Try It Out!
Easy-to-follow activity instructions

More Stuff
Additional challenges related to the science topic

Educator Pages

These two pages provide pre- and post-activities suggestions, background information, and resources.



Introduction
Overview of the section and science concepts

Mess Around
Warm-up activities to help explore materials and general science concepts

Try It Out!
Materials, directions, and hints for guiding the activities

Science Scoop
Simple explanations about the science concepts in the activities

More Stuff
Hints to help kids solve additional challenges

Resources
Helpful books, Web sites, and organizations related to the science topic

The ZOOMsci Activity Guide promotes habits of mind, or ways of thinking about and doing science, that help kids...

- **Be curious** and creative in their thinking about science and how it relates to their world. **Encourage** kids to ask "what if" and "why" questions and to consider evidence from many different perspectives. Foster kids' creativity and encourage them to take risks in their thinking and problem solving. Finding the right answer is not always as important as the process of seeking an answer. In science, unexpected results often lead to new insights and understandings.

- **Be observant.** Everything matters in science. Careful observation and data recording are crucial to understanding the outcome of an experiment or activity. **Encourage** kids to use not only their eyes and ears, but also instruments such as a ruler, stopwatch, or magnifying glass to observe, measure, and collect data and to figure out what they mean.

- **Develop critical thinking skills.** **Encourage** kids to ask questions, make predictions, and think critically. Help them analyze data from an activity and develop an explanation. Suggest they make comparisons and watch for patterns, which can reveal helpful information for solving a problem or answering a question.

- **Test their results.** Once kids have completed a science activity, help them explore their results. **Encourage** them to experiment with changing a variable. Do they get the same results? Why or why not?

- **Share their experiences** and data. **Encourage** kids to write about what they've learned, to draw pictures or graphs in their ZOOMjournal, or to keep computer records. And like a scientist, have them share that information with each other and with ZOOM.

Kids live in a world of motion and like to figure out how things go. Exploring motion offers them a chance to learn about forces. In this section, kids use air, rubber bands, baking soda and vinegar, and gravity to get things going. They make a *Balloon Car* zip across the floor, use a twisted rubber band to propel a *Pet Can*, create a chemical reaction that launches a *Film Canister Rocket* into space, and watch gravity pull a *Salt Pendulum* toward Earth while making "swinging" designs. In the process, they learn how stored (potential) energy can be turned into movement (kinetic energy).

s that go

air stuff

Air is all around us and it is constantly moving. It can also get other things moving. Hurricanes can move houses, wind propels sailboats, and even a little sneeze can send a sheet of paper flying. In this activity, kids learn how air can create a force that moves things. They explore how an air-filled balloon can power a milk carton.

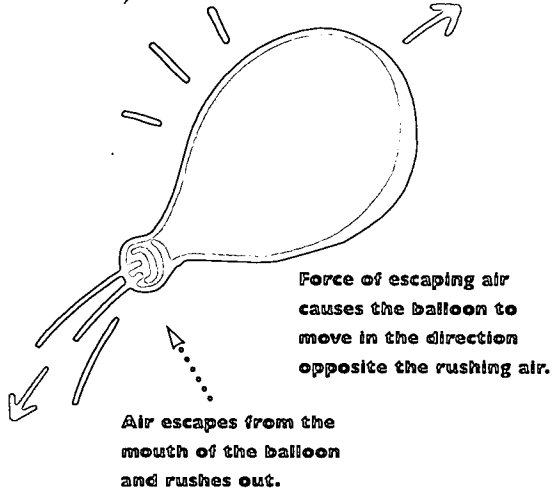
1 Mess Around

Warm up to the idea of air pressure with this activity. For each kid, you'll need one or two large balloons that are the same size and shape, a chalkboard or flip chart paper, and a measuring tape or ruler.

- Give each kid a balloon to blow up and release. Ask why the balloons zoomed around the room. Kids will probably guess that escaping air caused the balloons to fly. Ask them how they think air caused the balloons to fly.
- Ask kids to test whether the number of breaths in a balloon affects the distance it travels. Assign a number of breaths to each kid, to be blown into a balloon. Ask kids to predict how changing the number of breaths will affect how far the balloons travel. Have them inflate the balloons with the assigned number of breaths and release them. Use a stopwatch (or a watch with a second hand) to measure the amount of time the balloons are airborne. Chart the results on flip chart paper or a blackboard (see the sample chart). Review the chart data and ask the kids why they think the number of breaths affected the amount of time the balloons stayed aloft.

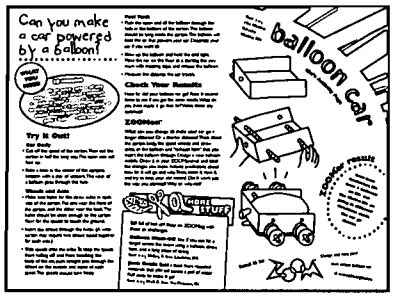
NUMBER OF BREATHS	SECONDS IN THE AIR
1	
2	
3	
4	
5	
6	
7	
8	

The Science Scoop Kids should make the connection between the number of breaths—or amount of air pressure—and the length of time the balloons stay in the air. They might even see variations within the same number of breaths if some kids blow larger breaths into the balloons. Obstacles in the room can also shorten air time. The balloons fly because the stretched rubber of the balloon presses on the air inside it. This "compression" increases air pressure. When the balloon is released, the higher pressure causes the air to rush out. Then Newton's third law of motion steps in. Newton's third law states that for every action there is an equal and opposite reaction (see the illustration below for how this works).



Ask kids for other examples of Newton's third law, such as pushing backward with one foot against the ground to make a skateboard go forward or shooting marbles.

2 Try It Out!



Read the activity instructions for Balloon Car on page 8 before starting.

Materials (for each kid or pair) milk or juice carton of any size • scissors • masking tape • ruler • 2–4 plastic drinking straws • 4 empty wooden or plastic thread spools of equal size • 8 straight pins • any size balloon (You will need additional cartons and balloons for the ZOOMon.)

Activity Preparation Ask kids to bring in empty, clean, and dry milk and juice cartons. Wooden or plastic spools are available at most arts and crafts supply stores, or check fabric stores for freebies. Make sure the straws fit inside the spool holes.

Try It Out! Have the kids work individually or in pairs. Challenge them to make a car that will go the farthest.

Check Your Results After the test drive, have kids analyze and discuss the different results.

ZOOMon Challenge kids to think about the main parts of the car—its body, wheels and axles, balloon, and "exhaust" hole. Could the parts be changed to make the cars go longer distances? To go shorter distances? Have them draw their new designs in their ZOOMjournals, label the changes, and predict the results. Then have them make and test the balloon cars again, write the results in their ZOOMjournals, and discuss how their changes worked.

The Science Scoop What makes a balloon car go? The amount of air pressure in the balloon affects how far the balloon car travels. But air pressure is not the only factor. The size of the exhaust hole also determines how quickly the air escapes from the balloon, which affects the distance. If the hole is too large, the air goes out too fast and the car may move only a little. If the hole is too small, the air does not come out fast enough and the result is the same. Kids might explore other design factors, such as balloon size and shape, car weight and shape, and wheel weight and placement. They could cut off some of the milk carton to make the body lighter, use a smaller milk carton, or vary the distance between the wheels by using shorter or longer straws.

3 More Stuff

Keep kids ZOOMing with the related challenges listed on the activity page. Here are some hints about how they work.

Balloon Blast-Off Attaching the string to a stationary object at one end and the target at the other makes a path along which the straw and balloon can zoom.

Junk Boats Collect recycled materials, such as Styrofoam plates, trays, and cups; packing material; boxes; and paper. You'll also need a large container of water, ideally a wading pool. At first kids can make a simple boat that floats. Then you can challenge them to make sails or figure out another way—besides puffing—to power a toy boat. They might explore using a balloon. Ask them where the balloon will release its air—into the water or against a sail. What challenges might a balloon boat present that a balloon car doesn't?

RESOURCES

Books

Ardley, Neil. *The Science Book of Motion.* San Diego: Harcourt Brace Jovanovich, 1992. Provides hands-on activities that teach middle-school kids about the basic principles of motion.

Ward, Alan. *Forces and Energy.* New York: Franklin Watts, 1992. A lavishly illustrated hands-on activity book aimed at middle-school kids.

Zubrowski, Bernie. *Balloons: Building and Experimenting with Inflatable Toys.* New York: William Morrow, 1990. Examines the properties of balloons with instructions for making an inflatable rocket car, monorail, boat, submarine, and more.

Web Sites

BOAST Balloon Car Page
http://boast.ccsm.uiuc.edu/lesson_kits/rocketcars/steps2.html
Presents a detailed balloon car activity adapted from *NASA's Rockets: Physical Science Educator's Guide with Activities.*

Homearts Network Rainy Day Projects: Building a Balloon Car Page
http://homearts.com/depts/family/00rain51.htm
Targeted to parents, presents another approach to building a balloon car and is a great source of additional balloon car ideas.

Can you make a car powered by a balloon?

WHAT YOU NEED

30 minutes

milk or juice carton of any size, rinsed and dried ○ scissors ○ masking tape ○ ruler ○ 2–4 plastic drinking straws ○ 4 empty wooden or plastic thread spools ○ 8 straight pins ○ balloon (any size)

Try It Out!

Car Body

- Cut off the spout of the carton. Then cut the carton in half the long way. The open side will face up.
- Poke a hole in the center of the carton's bottom with a pair of scissors. The neck of a balloon goes through this hole.

Wheels and Axles

- Make two holes for the straw axles in each side of the carton. Put one near the front of the carton, and the other near the back. The holes should be close enough to the carton floor for the spools to touch the ground.
- Insert the straws through the holes. (A wide carton may require two straws taped together for each axle.)
- Slide spools onto the axles. To keep the spools from rolling off and from touching the body of the car, push straight pins through the straws on the outside and inside of each spool. The spools should turn freely.

Fuel Tank

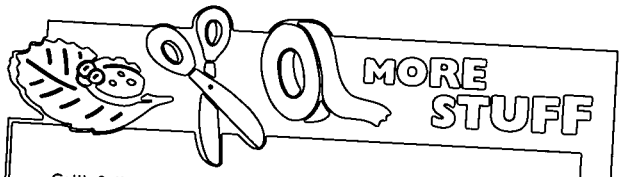
- Push the open end of the balloon through the hole in the bottom of the carton. The balloon should be lying inside the carton. The balloon will hold the air that powers your car. Decorate your car if you want to.
- Blow up the balloon and hold the end tight. Place the car on the floor at a starting line you mark with masking tape, and release the balloon.
- Measure the distance the car travels.

Check Your Results

How far did your balloon car go? Race it several times to see if you get the same results. What do you think made it go that far? Were there any surprises?

ZOOMon™

What can you change to make your car go a longer distance? Or a shorter distance? Think about the carton body, the spool wheels and straw axles, or the balloon and "exhaust hole" that you insert the balloon through. Design a new balloon-mobile. Draw it in your ZOOMjournal and label the changes you make. Include predictions about how far it will go and why. Then, make it, race it, and try to beat your old record. Did it work just the way you planned? Why or why not?



MORE STUFF

Still full of hot air? Keep on ZOOMing with these air challenges.

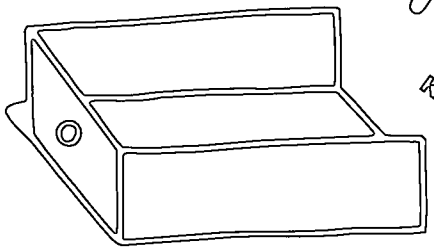
Balloon Blast-Off See if you can hit a target across the room using a balloon, straw, tape, and a long piece of string.
Sent in by Mallory B. from Lincolnton, GA

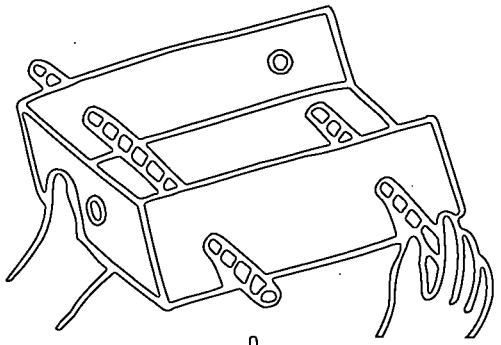
Junk Boats Build a boat from recycled materials that can sail across a pail of water. Puff away to make it go!
Sent in by Mark B. from San Francisco, CA

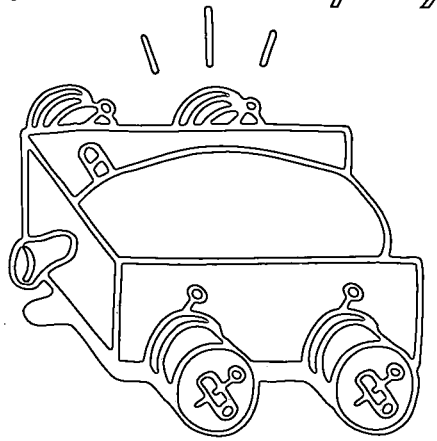
Sent in by the Weston School in Weston, MA

balloon car

Kid's Activity Page







ZOOMer result

Cela from Rochester, NY tried 3 balloons on her car. She thinks the air going in different directions made the car go slower.

Send it to ZOOM™

Design and race your own virtual balloon car at www.pbs.org/zoom.

rubber bands

Most kids know how to make a rubber band go. They stretch it, release it, and—zoom—it's across the room. The zip of a stretched rubber band is pretty exciting to kids, which is why rubber bands are perfect for introducing them to potential energy. In Pet Can, kids use the potential energy of a rubber band twisted around a weight to make a coffee can roll away and return to them. It's a lot safer than a loose rubber band flying across the room, plus they get to say "Here, Fido!" and the pet can rolls back to them.

1 Mess Around

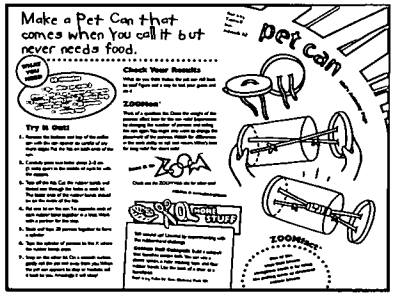
Ready to s-t-r-e-t-c-h kids' thinking?

Divide the group into teams and hold a contest to see who can shoot, or "sling," a rubber band the farthest. The teams can come up with "sling team" names. For safety, pass out rubber bands only when it's a kid's turn to sling, and collect them right after. The rubber bands should be of *equal length and thickness*. Use masking tape to mark a starting line and the landing sites. When the competition is over, ask kids to explain why some rubber bands flew farther than others. Kids will probably answer that the rubber bands that were stretched the most flew the farthest.

Have kids think of ways to test whether stretch accounts for distance. Let them try their suggestions. One way is to do a demo. Select three kids. Ask one to stretch a rubber band 1 inch before slinging; another, 2 inches; and the third, 3 inches. After slinging, measure the distances the rubber bands traveled. Ask what the connection is between stretch and distance traveled. What other things can they think of that use "stretch power"? Examples include slingshots, archery bows, catapults, and bungee cords.

The Science Scoop When kids stretch a rubber band, they give it energy. The more they stretch the rubber band, the more energy they use. Kids that stretched their rubber bands the farthest probably achieved the greatest distances, because the superstretched rubber bands had more energy available to be converted into motion. You might hear this called potential energy. If kids have a hard time with this concept, explain that it's energy that's waiting to be used. (Other factors affecting distance are aiming ability and obstacles in the room.)

2 Try It Out!



Read the activity instructions for Pet Can on page 11 before starting.

Materials (for each kid) 1 lb. coffee can with 2 plastic lids • can opener • scissors • 2 rubber bands • 20 pennies • masking tape • (You'll also need an additional 30–40 pennies for the ZOOMon.)

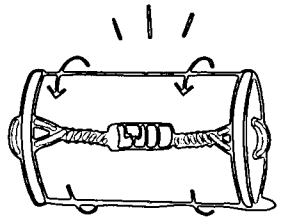
Activity Preparation Start collecting coffee cans with lids days before the activity. Kids will need two lids for each can, so they'll have to collect twice as many lids as cans. The size of the rubber bands is critical. Rubber bands that are approximately 3 inches long and 1/8 inch wide work best. Short rubber bands might not wind up; long ones might need too long a roll to wind.

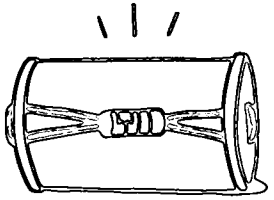
Try It Out! Tying the loose ends of the rubber bands is challenging. Encourage the kids to help each other: one child can hold the lid in place while the other one ties the knots.

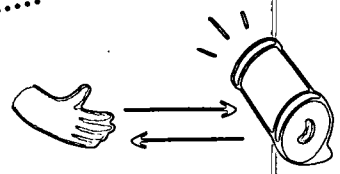
Check Your Results After the kids have rolled the can a few times, ask them what they think makes the can roll back. Can they figure out a way to test their guesses? To see how the pet can works, they could roll it a short distance, hold it in place, remove one lid, and look inside. Then they can put the lid back on, release the can, let it roll backward, and look inside again. Ask what they noticed and how the stack of pennies affected the pet can's motion.

ZOOMon Have kids experiment with changing variables, such as the weight's location or the number of pennies.

The Science Scoop What Makes the Pet Can Roll Back to You?







The rubber bands twist—increasing their potential energy—as kids roll the cans across the floor. They twist because the attached weights—stacks of pennies—provide resistance by remaining mostly stationary as the cans roll. The potential energy is released as the rubber bands untwist. This potential energy is used up by making kinetic energy (the energy of something moving) that transfers to the can, making it move.

By changing the number of pennies, kids discover that the greater the weight, the more the rubber bands twist. The more the rubber bands twist, the more potential energy they have to return the pet cans. But, when the pennies become too heavy, they pull the rubber bands to the bottom of the can.

RESOURCES

Books

Ardley, Neil. *Making Things Move*. New York: Franklin Watts, 1984. Contains illustrated experiments demonstrating basic principles of forces and motion.

Johnston, Tom. *The Forces with You!* Milwaukee: Gareth Stevens, 1988. Explains how forces such as gravity, friction, elasticity, and inertia and agents of force such as leverage and balance affect our lives.

Web Sites

Instructions to Build the Cotton-Spool Tank
http://www.nfra.nl/~mgoris/mechtoys/tank.html
Detailed instructions for making a rubber band-powered toy that climbs over small obstacles.

Penny Power
http://www.forks.wednet.edu/middle/techpage/penny.html
Contains a challenge and instructions for building a rubber band-powered catapult.

3 More Stuff

Keep kids' minds elastic with this challenge listed on the Kid's Activity Page. Here's how it works.

Cotton Ball Catapult One way to make a catapult is to attach a plastic spoon to a ruler, then attach the ruler-spoon combination to the back of a chair with a rubber band. Kids might come up with other ways. Try them! Can kids find a way to catapult the cotton balls farther? Hint: Increase the weight of the cotton balls.

Make a Pet Can that comes when you call it but never needs food.

Sent in by Tristan B. from Jacksonville, AZ

Pet Can

Kid's Activity Page

WHAT YOU NEED

30 minutes

1 lb. coffee can with 2 plastic lids ○ can opener ○ scissors ○ 2 rubber bands (about 3 inches long and not too thin) ○ 20 pennies ○ masking tape

Try It Out!

1. Remove the bottom and top of the coffee can with the can opener. Be careful of any sharp edges. Put the lids on both ends of the can.
2. Carefully poke two holes about 2–3 cm (1 inch) apart in the middle of each lid with the scissors.
3. Take off the lids. Cut the rubber bands and thread one through the holes in each lid. The loose ends of the rubber bands should be on the inside of the lids.
4. Put one lid on the can. Tie opposite ends of each rubber band together in a knot. Work with a partner for this step.
5. Stack and tape 20 pennies together to form a cylinder.
6. Tape the cylinder of pennies to the X where the rubber bands cross.
7. Snap on the other lid. On a smooth surface, gently roll the pet can away from you. When the pet can appears to stop or hesitate, call it back to you. Amazingly, it will obey!

Check Your Results

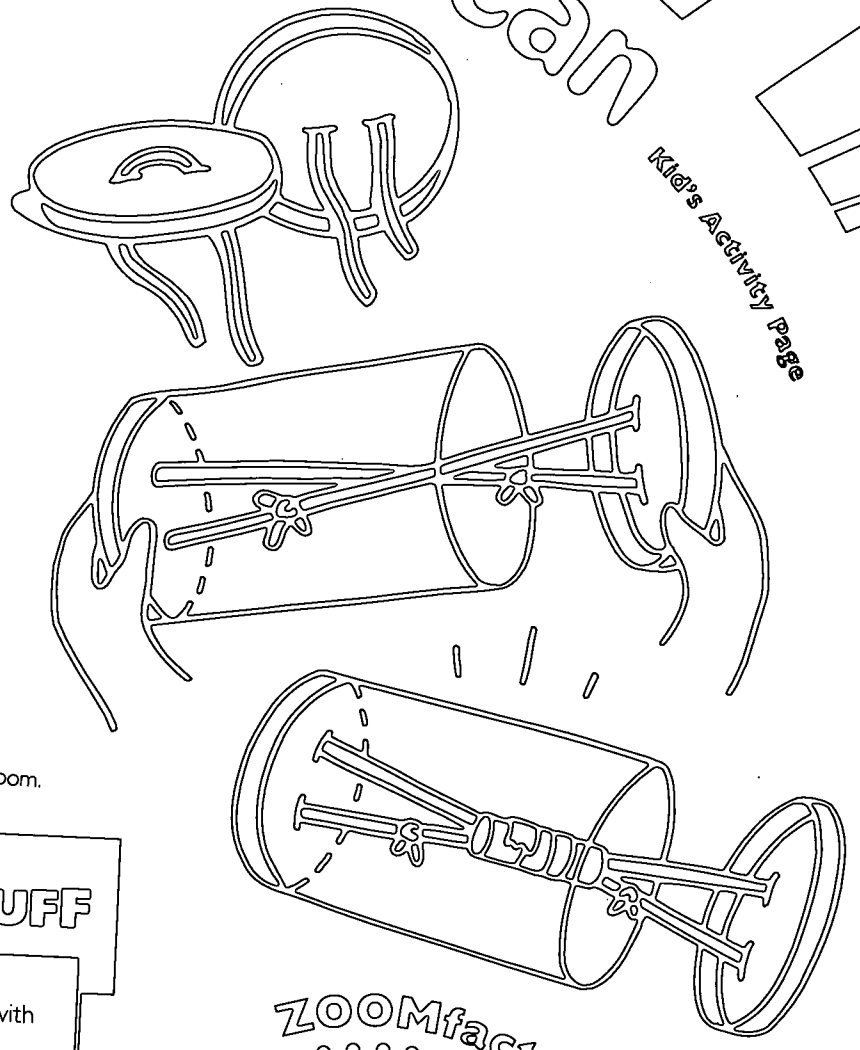
What do you think makes the pet can roll back to you? Figure out a way to test your guess and do it.

ZOOMon™

Think of a question like, Does the weight of the pennies affect how far the can rolls? Experiment by changing the number of pennies and rolling the can again. You might also want to change the placement of the pennies. Watch for differences in the can's ability to roll and return. What's best for long rolls? For short rolls?

Send it to ZOOM™

Check out the ZOOM Web site for other cool activities at www.pbs.org/zoom.



MORE STUFF

Still wound up? Unwind by experimenting with this rubber-band challenge.

Cotton Ball Catapult Build a catapult that launches cotton balls. You can use a plastic spoon, a ruler, masking tape, and four rubber bands. Use the back of a chair as a launchpad.

Sent in by Cullen W. from Orchard Park, NY

ZOOMfact™

One of the ways that braces straighten teeth is by using the pulling force of stretched rubber bands!

baking soda and vinegar

If someone hands you a can of soda that's been shaken, would you open it? Probably not. You would realize that if you opened it—splash—the soda would explode all over you and half the room. If you have experienced this, you know just how powerful contained carbon dioxide gas, or any gas, can be. In this activity, kids use "bubble power" to make a film canister rocket blast off. To make the bubbles, they use carbon dioxide gas, which is generated from the chemical reaction caused by mixing baking soda and vinegar.

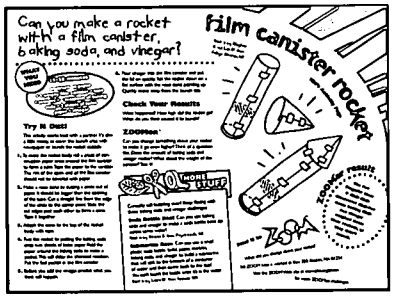
1 Mess Around

Have some fun with fizz power.

Have kids put a teaspoon of baking soda in a sealed plastic bag, then have them add vinegar. Talk about what they see.

The Science Scoop The kids will see the chemical reaction between the baking soda and vinegar. This mixture will foam up, expand, and finally fizz out. If they put enough baking soda and vinegar in the sealed bag, the gas created by the chemical reaction will cause the bag to expand too. Kids will have to close the bag quickly to see it expand. Chemical reactions happen when atoms in the molecules of the materials you mix recombine and create new molecules, or substances. Other times, the molecules simply become a mixture, but not a new substance.

2 Try It Out!



Read the activity instructions for Film Canister Rocket on page 14 before starting.

Materials (for each pair) construction paper ∘ 1 empty film canister ∘ tape ∘ scissors ∘ baking soda ∘ a few squares of toilet paper ∘ vinegar

Activity Preparation Before kids add the fuel to the rocket, ask them to predict what will happen and why.

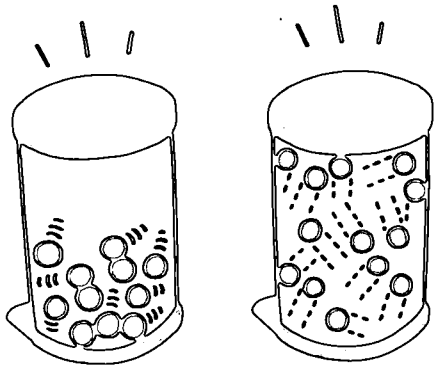
Try It Out! This is a messy activity, so cover the work area or do it outside. Before having kids add the "fuel" to the rocket, have them predict what will happen. Because there isn't much time between adding the vinegar and the blast off, it's best to have kids work in pairs so that they can assist each other with fuel loading.

Check Your Results Have the kids explain what happened. Are there similarities between what happened when they mixed the baking soda and vinegar in the plastic bag and the film canister rocket?

ZOOMon Challenge kids to change something about their rocket—the amount of baking soda and vinegar or the weight—to make it go higher. How high do they think it will go? Have them test it out.

The Science Scoop What happens to the baking soda and vinegar inside the canister? When the kids combined the baking soda and vinegar, a chemical reaction occurred and carbon dioxide—a new substance—was created. As more and more gas was created, the pressure built up. Eventually the carbon dioxide gas trapped in a film canister pushed the top off the canister.

Diagram of Chemical Reaction



baking soda and vinegar **carbon dioxide gas**

3 More Stuff

Try the baking soda and vinegar challenges listed on the Kid's Activity Page. Here's a quick look at what's involved.

Soda Bottle Boat The trick is to delay the chemical reaction by wrapping the baking soda in toilet paper. Kids should poke a small hole in the bottle cap and place a few marbles in the bottle to pull it down into the water a bit. The gas from the chemical reaction can then escape through a hole in the bottle cap. The escaping gas propels the bottle across the water.

Submarine Race The secret is to delay the chemical reaction in the bottle so that the bottle sinks first, and then resurfaces. Use just enough marbles to submerge the bottle, but not so many that it won't come back up. Squeeze the bottle to get as much air out of it as possible. Once the chemical reaction occurs, the bottle should fill with gas and rise to the surface.

RESOURCES

Books

Kerrod, Robin. *Force and Motion.* North Bellmore, NY: Marshall Cavendish, 1994. Illustrates with simple examples and experiments the principles behind natural forces and the motions they create, as well as their effects and how they can be used.

Sarquis, Jerry, Lynn Hogue, Mickey Sarquis, and Linda Woodward. *Investigating Solids, Liquids, and Gases with Toys.* New York: McGraw-Hill, 1997. Includes 24 activities for middle-school kids using common toys and household items to explore states of matter and changes of state.

Web Sites

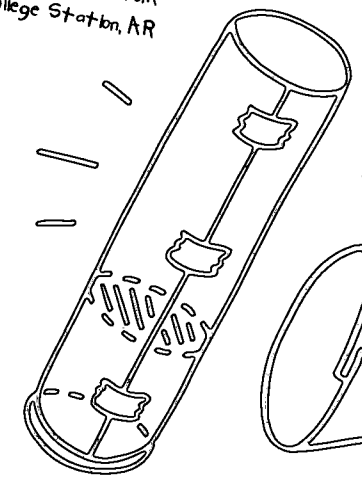
Chem 4 Kids
http://www.chem4kids.com/
A user-friendly reference for middle-school kids, with sections on matter, elements, atoms, and reactions.

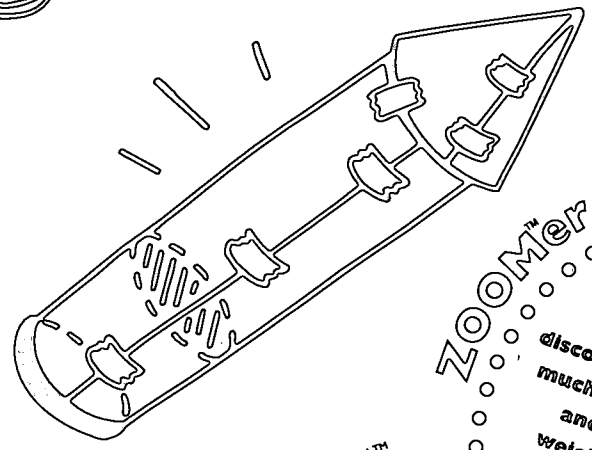
Can you make a rocket with a film canister, baking soda, and vinegar?

Film canister rocket

Sent in by Meghan S. and Lee M. from College Station, AR

Kid's Activity Page





WHAT YOU NEED

15–20 minutes

construction paper ○ 1 empty film canister ○ tape ○ scissors ○ 1 teaspoon of baking soda ○ 2 sheets of toilet paper ○ vinegar

Try It Out!

This activity works best with a partner. It's also a little messy, so cover the launch area with newspaper or launch the rocket outside.

1. To make the rocket body, roll a piece of construction paper once around the film canister to form a tube. Tape the paper to the canister. The rim of the open end of the film canister should not be covered with paper.
2. Make a nose cone by cutting a circle out of paper. It should be bigger than the opening of the tube. Cut a straight line from the edge of the circle to the center point. Slide the cut edges past each other to form a cone. Tape it together.
3. Attach the cone to the top of the rocket body with tape.
4. Fuel the rocket by putting the baking soda onto two sheets of toilet paper. Fold the paper around the baking soda to make a packet. This will delay the chemical reaction. Put the fuel packet in the film canister.
5. Before you add the vinegar, predict what you think will happen.
6. Pour vinegar into the film canister and put the lid on quickly. Set the rocket down on a flat surface with the nose cone pointing up. Quickly move away from the launch site.

Check Your Results

What happened? How high did the rocket go? What do you think caused it to launch?

ZOOMon™

Can you change something about your rocket to make it go even higher? Think of a question like, Does the amount of baking soda and vinegar matter? What about the weight of the canister? Test it!

MORE STUFF

Curiosity still bubbling over? Keep fizzing with these baking soda and vinegar challenges.

Soda Bottle Boat Can you use baking soda and vinegar to make a soda bottle boat zip across some water?

Sent in by Steven B. from Fayetteville, AR

Submarine Race Can you use a small plastic soda bottle, toilet paper, marbles, baking soda, and vinegar to build a submarine that will sink to the bottom of a container of water and then come back to the top? You can't touch the bottle once it's in the water.

Sent in by Laura G. from Andover, MA

ZOOMer result

The San Dieguito Boys & Girls Club discovered that too much baking soda and vinegar weighed down their rockets, so they didn't launch.

Send it to ZOOM™

What did you change about your rocket?

Tell ZOOM how it worked at Box 350, Boston, MA 02134.

Visit the ZOOM Web site at www.pbs.org/zoom for more ZOOMsci challenges.

gravity

Remember riding on a swing? Just as you reached the highest point, you always swung back down. You can blame your return to Earth on gravity, the force that pulls everything down toward the ground. Gravity not only is a force that stops motion, it can also make beautiful artwork! In this activity, kids experiment with gravity by making a salt pendulum. A pendulum is any weight suspended from a fixed point that swings in an arc. The weight for the salt pendulum is a cone filled with salt. As the pendulum swings, it leaves an interesting pattern of salt. Think of it as gravity's artistic creation.

1 Mess Around

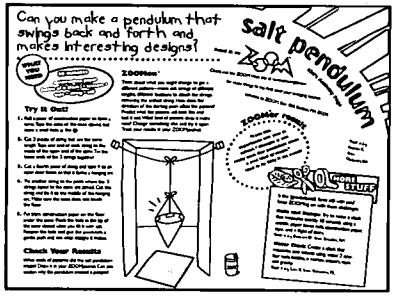
While you're still thinking about swings, here are some warm-ups to get kids thinking about gravity. You'll need string, a weight, a stopwatch (or a watch with a second hand), and a playground with a swing set.

- Make a simple pendulum by tying one end of a two-foot length of string to a small weight, such as a key, and taping the other end to a table or top of a door frame. Ask the kids to watch carefully what happens when you pull the key to one side and release it. Then shorten the string, release the key from the same point, and ask the kids if anything changed. Tell them it's a pendulum.
- Take the kids to a park or school yard with swings to test a larger pendulum. Find two swings of different heights, or you can create different swing heights using two metal S-shaped hooks to shorten a swing's chain. Give the stop watch to a "timekeeper." Select one kid to be the "weight" and have him or her sit on the low swing, and back up as far as possible. Mark this spot with a stone, then tell the passenger to swing without "pumping." Have the timekeeper measure the amount of time it takes to make one complete swing forward and back again. (Note: If you can't get to a swing set, you can model this activity with strings and different-sized weights inside your building.)

Get kids guessing about what makes the swing move a long or short time. Test the swing with a smaller or larger kid. Make sure the kid starts at the same point. Have the group predict how long this differently weighted swing will take. Repeat the experiment with the higher swing. Define pendulum. Ask the kids how the pendulum and the swing are the same.

The Science Scoop Think back to the playground. The pendulum periods were affected not by weight but by length of string. So, the low swing should have taken the same amount of time to complete its arc regardless of whether it was carrying the smaller or the larger kid. However, when the kids switched to the higher swing—which had shorter chains—the amount of time to complete the arc should have been shorter. A long string makes the pendulum's period longer, and a short string makes the period shorter.

2 Try It Out!



Read the activity instructions for Salt Pendulum on page 17 before starting.

Materials (for each kid) construction paper (some of it black) ∘ scissors ∘ tape ∘ string ∘ salt

Activity Preparation You'll need secure points from which the kids can hang their pendulums and floor space under these points so they can place paper to catch the falling salt.

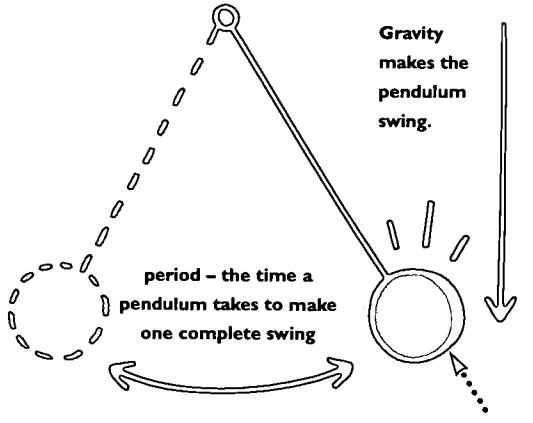
Try It Out! Hand out materials and make the salt pendulum.

Check Your Results After doing the activity, discuss the patterns their pendulum made and what may have caused them. Have kids draw their patterns in their ZOOMjournal.

ZOOMon Challenge kids to create a different pattern by changing the design of the pendulum. They might change string length or location, number of strings, amount of salt, or whatever they can think of. Have them record their design and results in their ZOOMjournals and compare them.

The Science Scoop What will the pendulum's pattern look like? The patterns will have circular and oval shapes overlapping each other at varying angles. Unlike a simple pendulum attached to a single fixed point, this pendulum attaches to another string, which also moves. The patterns are created by the interaction between the motion of the looped string and the motion of the swinging pendulum. So you really have two pendulums moving somewhat independently in different directions.

How a Pendulum Works



When the pendulum reaches one end of its swing, potential energy and gravity cause it to swing back the other way.

RESOURCES

Books

Cash, Terry. *101 Physics Tricks*. New York: Sterling, 1992. Provides information on such topics as gravity, friction, sound, magnetism, light, heat, and energy, and includes activities and experiments illustrating various principles.

Lafferty, Peter. *Force and Motion*. New York: DK Publishing, 1992. Explores the principles of force and motion, describing how they have been applied from ancient to modern times.

Web Sites

Playground Physics—Swing Set Physics
http://lyra.colorado.edu/sbo/mary/play/pendulum.html
Contains a somewhat more technical approach to learning about the physics of pendulums using swing sets.

Usenet Physics FAQ
http://erwin.phys.virginia.edu/Education/Teaching/HowThingsWork/resources.html
Provides answers to FAQ (frequently asked questions) about physics.

3 More Stuff

Keep kids ZOOMing with the gravity challenges listed on the Kid's Activity Page. Here are some tips and hints.

Balls and Ramps Kids can slow the marble and impact of gravity in many ways. They can create a fairly complex system of ramps, with lots of turns to increase the distance the marble must travel. They can also make the ramp slopes less steep and place obstacles, like speed bumps, in the way of the marble.

Water Clock Punch small holes in one bottle cap. Fill its bottle halfway with water and tape it to the other, opening to opening, with the cap off the second bottle. One way to test the timing is to turn the bottles upside down, and using a marker and a timer, mark the level of the water in the bottle on the bottom when one minute has passed.

Can you make a pendulum that swings back and forth and makes interesting designs?

Salt pendulum

Kid's Activity page

WHAT YOU NEED

30 minutes

construction paper ○ scissors ○ (some of it black) ○ tape ○ string ○ salt

Try It Out!

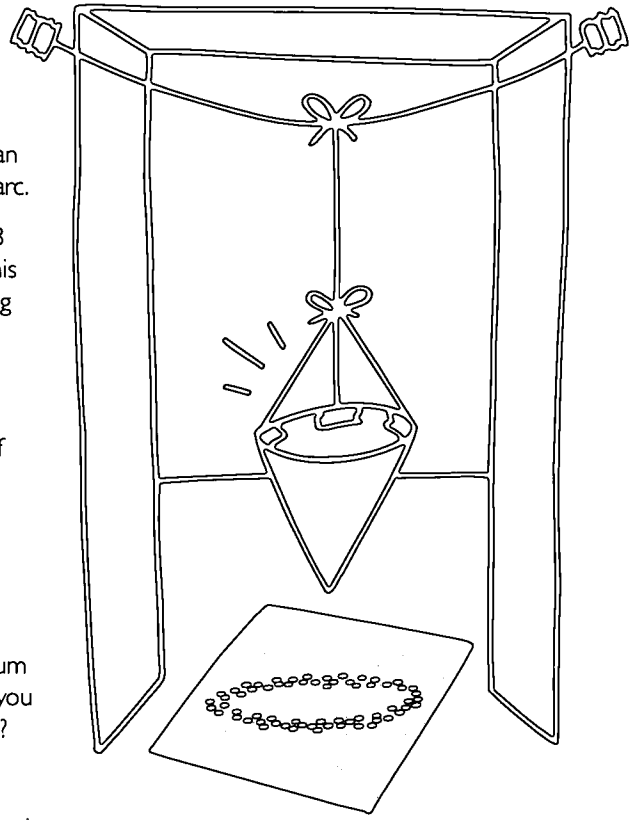
1. Roll a piece of construction paper to form a cone. Tape the sides of the cone closed, but leave a small hole at the tip.
2. Cut 3 pieces of string that are the same length. Tape one end of each string to the inside of the open end of the cone. Tie the loose ends of the 3 strings together.
3. Cut a fourth piece of string and tape it to an open door frame so that it forms a hanging arc.
4. Tie another string to the point where the 3 strings taped to the cone are joined. Cut this string and tie it to the middle of the hanging arc. Make sure the cone does not touch the floor.
5. Put black construction paper on the floor under the cone. Pinch the hole in the tip of the cone closed while you fill it with salt. Reopen the hole and give the pendulum a gentle push and see what designs it makes.

Check Your Results

What kinds of patterns did the salt pendulum create? Draw it in your ZOOMjournal. Can you explain why the pendulum created a pattern?

ZOOMon™

Think about what you might change to get a different pattern—more salt, strings of different lengths, different locations to attach the strings, removing the arched string. How does the direction of the starting push affect the pattern? Predict what the pattern will look like and test it out. What kind of pattern does it make now? Change something else and try it again. Track your results in your ZOOMjournal.



Send it to ZOOM™

Check out the ZOOM Web site at www.pbs.org/zoom for more things to try. And send your swinging science activities to ZOOM, Box 350, Boston, MA 02134

ZOOMer result™

"I did this experiment last year in school. I thought it was really cool. Our pendulum made a oval kind of shape." Sent in by Tiffy P. via e-mail

Sent in by Andrea C. from Cincinnati, OH

MORE STUFF

Is the (gravitational) force still with you? Keep ZOOMing on with these challenges.

Balls and Ramps Try to make a clock that measures exactly 10 seconds using a marble, paper towel rolls, construction paper, tape, and a flight of stairs.
Sent in by Barbara G. from Brookline, NH

Water Clock Create a clock that measures one minute using water, 2 one-liter soda bottles, a marker, scissors, tape, and gravity.
Sent in by Lisa R. from Sarasota, FL

Exploring nature through observing and counting helps kids appreciate the ways in which nature regenerates itself. In *Compost Column*, kids make plant nutrients—compost—by placing table scraps inside recycled soda bottles. In *Biodome*, they also use soda bottles to make their own little ecosystem inside additional soda bottles to explore plant growth and the water cycle. Using common household materials, kids also make a *Germinator*, which allows them to observe seeds sprouting and to experiment with variables that affect germination. Finally, they observe birds by attracting them to a *Bird Feeder* they build themselves.

compost

Even if you've never intentionally composted, you may have left something on a shelf in your refrigerator for so long that it started to decompose. Remember that soggy cucumber? How about that bread that grew green fuzz? Not very appealing, was it? When kids pack their sticky, sloppy kitchen scraps into the compost columns they make in this activity, they will no doubt hold their noses and act disgusted. But they'll be interested in the process that turns table scraps into reusable "dirt" that can provide nutrients for plants.

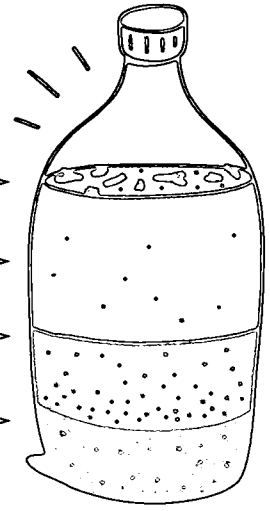
1 Mess Around

Have kids dig into the subject of soil by asking them if they think that all soil is the same.

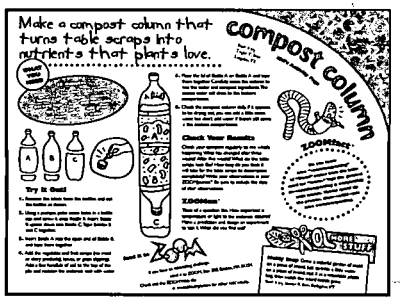
Ask kids to bring in soil from around the neighborhood in small clear plastic soda bottles. Ask them to label the bottles with the location from which they got the sample. Tell kids to look closely at their soil sample using a hand lens if you have one. What do they see? Have them note their observations in their ZOOMjournals. Tell them to add enough water to the bottles to submerge the soil. Then have them shake the bottles for a minute and set them aside for ten minutes. What do they see now? Do all the samples look the same? Ask them to add any new observations to their ZOOMjournals.

The Science Scoop Not all soil is the same. Soil can be very rocky or sandy or contain a lot of clay. Soil is a mixture of particles. Some particles are tiny pieces of rocks, and others are pieces of organic material known as humus—the remains of dead plants and animals, usually in the form of tiny fibers or fragments. Humus is usually located near the surface of the soil.

When kids add water to their soil samples and shake them, the water helps to separate the ingredients. Because humus doesn't weigh as much as the inorganic material, it usually floats on top. Sand and pebbles sink to the bottom. The compost that kids make eventually turns into humus.



2 Try It Out!



Read the activity instructions for Compost Column on page 21 before starting.

Materials (for each kid) scissors • 3 two-liter soda bottles • 2 bottle caps • a pushpin • masking or packing tape • fruit and vegetable scraps (kids can also add grass and leaves) • soil • water

Activity Preparation Several days before starting this activity, tell kids to collect vegetable and fruit scraps in a plastic bag. Ask them not to include meat or dairy products because these create smelly compost that can be a breeding ground for harmful bacteria.

Try It Out! This activity takes a few weeks to several months, depending on your kids' enthusiasm. Kids may need help cutting the bottles. If the bottles have hard plastic bases, you need to remove them. Soak the bottles in very hot water to soften the glue that holds the base. When they cool, twist off the bases.

Check Your Results Check the mixture regularly. After three weeks, have kids discuss their observations. Has the compost turned into something that looks like soil, or is it in a state of soupy decay? Have them predict what it will look like in several months.

ZOOMon Have kids design their own experiment to test variables that affect the compost. One way to test temperature (or light) is to put fruit and vegetable scraps in two plastic bags. Keep one bag in a warm place, and the other in a cool place (or one in a light place, and the other in a dark place). Predict what will happen and observe the bags over time. For a good result, it's best if the temperature difference between the bags is at least ten degrees Fahrenheit. The compost bag in the warmer location should be noticeably further along in the decomposition process even after just one week. Compost placed in the dark will usually grow more mold or fungi.

The Science Scoop How long does it take for the fruit and vegetable scraps to decompose? Kids need to add soil to the scraps because the soil contains microscopic organisms that begin the composting process. In composting, these microscopic organisms break down biodegradable materials (materials that will decompose) into nutrients, which can be used for growing plants. This process takes time. The first sign of change may occur in a few days as bacteria start attacking the fruit and vegetable scraps. Later, fungi may appear. Tiny visible animals—such as mites, worms, flies, and beetles—also help the decomposition process. It can take as long as six months for the nutrients in the scraps to be converted to forms that plants can use to grow, but there will be noticeable changes in three or four weeks. Make the connection between the humus floating in the soil samples the kids tested a few weeks ago and the compost that their table scraps will eventually turn into.

RESOURCES

Books

Burnie, David. *How Nature Works.* Pleasantville, NY: Reader's Digest Association, 1991. Explores a wide range of living organisms and systems, from microorganisms to ecologies through experiments and projects.

Ring, Elizabeth. *What Rot! Nature's Mighty Recycle.* Brookfield, CT: Millbrook Press, 1996. An introduction to composting and other natural recycling processes.

Web Sites

EPA Explorers' Club
http://aggiehorticulture.tamu.edu/county/smith/kids.html
Home page of the U.S. Environmental Protection Agency's Explorers' Club. Has fun activities and information on the environment, recycling, air, water, and plants and animals.

Rot Web
http://net.indra.com/~topsoil/Educator_Resources.html
Contains resources for educators, discussions of composting projects for kids, and links to other composting web resources.

3 More Stuff

Keep kids ZOOMing with another slimy challenge listed on the Kid's Activity Page. Here's how it works.

Moldy Soup Different mold species are present in the air and all around us. Several will grow on bread, including black and green mold.

Compost Column

Kid's Activity page

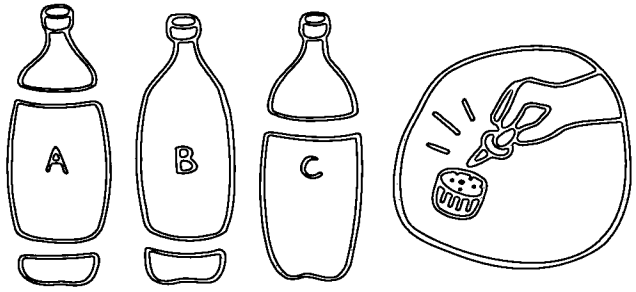
Sent in by Taylor T. from Longview, TX

Make a compost column that turns table scraps into nutrients that plants love.

WHAT YOU NEED

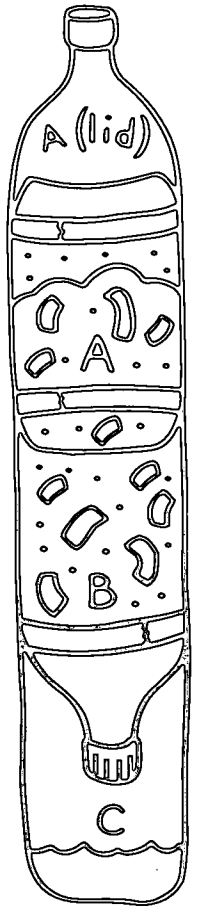
30 minutes

scissors ○ 3 two-liter soda bottles ○ 2 bottle caps ○ pushpin ○ masking or packing tape ○ fruit and vegetable scraps (you can also add grass and leaves) ○ soil ○ water



Try It Out!

1. Remove the labels from the bottles and cut the bottles as shown.
2. Using a pushpin, poke some holes in a bottle cap and screw it onto Bottle B. Insert Bottle B upside down into Bottle C. Tape Bottles B and C together.
3. Insert Bottle A into the open end of Bottle B, and tape them together.
4. Add the vegetable and fruit scraps (no meat or dairy products), leaves, or grass clippings. Add a few handfuls of soil to the top of the pile and moisten the materials well with water.



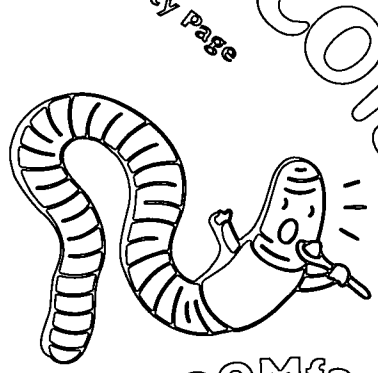
5. Place the *lid* of Bottle A on Bottle A and tape them together. Carefully shake the column to mix the water and compost ingredients. The excess water will drain to the bottom compartment.
6. Check the compost column daily. If it appears to be drying out, you can add a little more water, but don't add water if there's still some in the bottom compartment.

Check Your Results

Check your compost regularly to see what's happening. What has changed after three weeks? After five weeks? What do the table scraps look like? How long do you think it will take for the table scraps to decompose completely? Write your observations in your ZOOMjournal.™ Be sure to include the date of your observations.

ZOOMon™

Think of a question like, How important is temperature or light to the compost column? Make a prediction and design an experiment to test it. What did you find out?



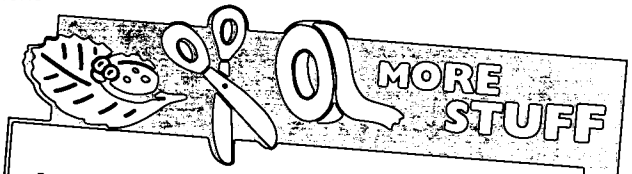
ZOOMfact™

Do you know what "vermicomposting" is? "Vermi" comes from the Latin word for "worm." Yep! You guessed it—vermicomposting is composting with worms. Worms speed up the process, then—voilà!—you have vermicomposting.

Send it to ZOOM™

If you have an interesting challenge, send it to ZOOM, Box 350, Boston, MA 02134

Check out the ZOOM Web site at www.pbs.org/zoom for other kids' results.



Moldy Soup Grow a colorful garden of mold on a piece of bread. Just sprinkle a little water on a piece of bread, seal it in a resealable plastic bag, then watch the weird molds grow.

Sent in by Jessica S. from Burlington, VT

biodome

Here's a fun way to recycle two-liter soda bottles—turn them into mini-ecosystems. An ecosystem is a community of plants, animals, and nonliving materials. Using two-liter soda bottles, kids can build closed ecosystems that provide plants with air, water, and nutrients. The transparent bottles allow kids to observe plant growth, from root formation to first leaves and a miniature water cycle.

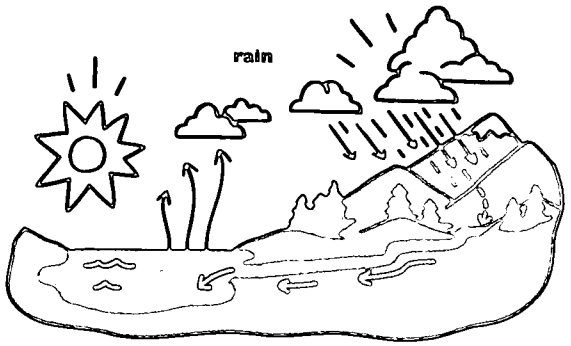
1 Mess Around

These warm-ups help kids begin to think about the water cycle, which is an important part of their biodomes and plant growth.

To demonstrate evaporation, which is the process by which liquid turns into a gas, you'll need a clear plastic cup, glass, or jar; a piece of plastic wrap; a rubber band; and water for each kid. Tell kids to fill their containers half full with water, cover them tightly with the piece of plastic wrap, seal them with a rubber band, and set them aside. Have kids look at their container every fifteen minutes for an hour or so. What do they notice? (Results will vary depending on the temperature of the water and surrounding air.)

To demonstrate transpiration, which is the evaporation of water from the above ground parts of plants, you'll need a potted plant and a gallon-sized plastic freezer bag. Put the plant inside the plastic bag, seal the bag, and place it in the sun or a warm place. After several hours, ask kids what they observe inside the plastic bag.

The Science Scoop During the evaporation demonstration, kids should notice water droplets forming on the inside of the plastic wrap. The water in the container evaporates and condenses into droplets. Condensation happens because the plastic wrap is colder than the water vapor. This demonstrates the Earth's water cycle. Moisture evaporates from rivers, lakes, oceans, and other bodies of water. This moisture condenses in the air, forms clouds, and later falls back to Earth as precipitation (snow, rain, and hail).



In the transpiration activity, after several hours, the bag covering the house plant will have water droplets on the inside. The water droplets are evidence that plants transpire, taking in water through their roots and moving it up their stems and into their leaves. The water is then released through tiny holes, called stomata, usually located on the underside of the leaves. This water starts to evaporate and condenses on the bag. In nature, the water from the plants adds to the condensation in the air.

Try It Out!

Read the activity instructions for Biodome on page 24 before starting.

Materials (for each kid) 3 two-liter soda bottles ∘ a pushpin ∘ a bottle cap ∘ scissors ∘ thick cotton string ∘ water ∘ potting soil ∘ seeds ∘ masking or packing tape

Activity Preparation Collect seeds or have kids bring them from home.

Try It Out! Kids may need help cutting the bottles. If the bottles have hard plastic bases, you need to remove them. Soak the bottles in very hot water to soften the glue that holds the base. When they cool, twist off the bases.

Check Your Results After kids make their biodomes, ask them to predict what will happen. Will the plants grow? What will happen to the water? Have them observe the biodome over time and see what happens. Did the plants grow? Has the water gone down? They should write and draw their observations in their ZOOMjournal.

ZOOMon If kids test the effect of temperature, tell them to make sure the two locations they choose have the same amount of light. Otherwise, they wouldn't be be able to tell whether the changes were caused by temperature or by light. Warmer locations should result in a faster water cycle, with evaporation, condensation, and precipitation happening more quickly. When testing for light, kids should make sure the two locations have the same temperature.

The Science Scoop What will happen to the water in the biodome? Does the biodome run out of water? Just like the water on Earth, the water in the biodome is continually recycled through the processes of evaporation, condensation, and precipitation. You might want to begin a discussion by asking kids to think about where water comes from on Earth. You can ask them to draw a picture that explains the water cycle. Tell them to use arrows to show where the water comes from and where it goes.

3 More Stuff

Keep kids' interest growing with this challenge listed on the Kid's Activity Page. Here are some tips and hints.

Plant Race A number of variables could affect this "race." The humidity will be higher in the closed environment of the biodome, which will usually result in better growing conditions. However, if kids overwater the seedlings in the biodome, the soil could become too moist, causing root rot.

RESOURCES

Books

Savan, Beth. *Earthwatch, Earthcycles, and Ecosystems.* Reading, MA: Addison-Wesley, 1991. A middle-school-level introduction to ecological systems.

Sisson, Edith. *Nature with Children of All Ages.* New York, NY: Prentice-Hall, 1982. Perfect for educators, parents, or group leaders who want hands-on nature activities for kids.

University of Wisconsin. *Bottle Biology.* Dubuque, IA: Kendall/Hunt Publishing, 1993. A collection of environmental science investigations that you do with recycled soda bottles.

Web Sites

Ecology Kids
http://www.1000friends.org/~friends/e-kids.htm
Devoted to ecology for kids with links to other interesting sites, including some about mountain gorillas and frogs, and one with an interactive world map.

Kids Do Ecology
http://www.nceas.ucsb.edu/nceas-web/kids/main.html
Learn about ecology and ecology-related activities for kids. Home page made possible by the National Center for Ecological Analysis and Synthesis (NCEAS).

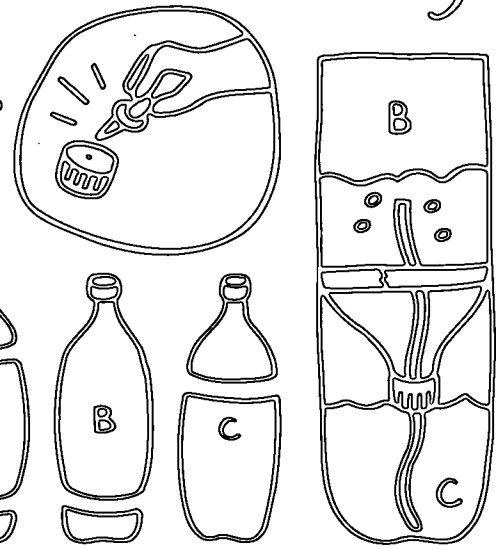
Seasoned Investigations
http://www.arboretum.harvard.edu/csc/seasonal/index.htm
Designed for elementary-school kids, this site supports a year-long investigation of how trees change.

Can you make a biodome where plants can live without having to be watered?

WHAT YOU NEED

30–45 minutes

3 two-liter soda bottles ○ a pushpin ○ a bottle cap ○ scissors ○ thick cotton string ○ water ○ potting soil ○ seeds ○ masking or packing tape



Try It Out!

1. Remove the labels from the bottles. Cut the bottles as shown.
2. Using a pushpin, poke a hole in the center of the bottle cap, and use scissors to enlarge the hole so the string fits through. Soak a piece of string about 30 centimeters (12 inches) long in water, and thread it through the hole. Screw the cap onto Bottle B, letting half of the string hang inside the bottle.
3. Fill Bottle C about two-thirds with water. Turn Bottle B upside down, and insert it into Bottle C. The bottle cap and about half of the string should be in the water. Tape B and C together.
4. Holding the string upright, place several handfuls of potting soil into Bottle B, so that the soil surrounds the string. The string should be in the middle of the soil, not against the side of the bottle. The string will draw the water up into the soil for the plants.
5. Using the tip of your finger, poke a hole about 2-3 cm (1 inch) deep in the center of the soil. Drop two or three seeds into the hole, cover the hole with soil, and add water to moisten the soil.
6. Insert Bottle A into Bottle B, and tape them together. Place the top of Bottle A on Bottle A, and tape them together.

Check Your Results

What do you think will happen in the biodome? Observe it regularly and record what happens in your ZOOMjournal.™ Did your plants grow? How tall? Did the biodome run out of water?

ZOOMon™

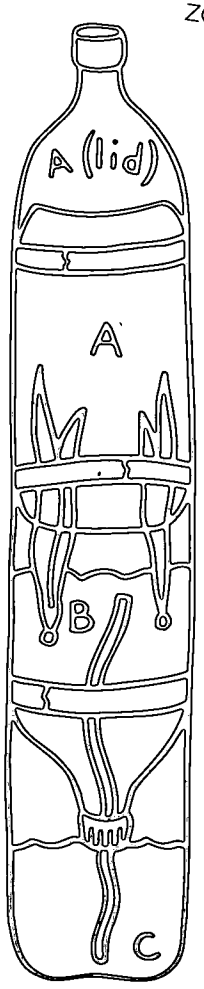
Think of a question like, How does light or temperature affect the plants in the biodome? Make a prediction and then try to find out. Keep your biodome in a warm (or sunny) place for two weeks and observe any changes. Then move it to a much cooler (or dark) place for two weeks and observe again. Don't forget to write your observations in your ZOOMjournal. Look at things like plant growth, moisture of the soil, and anything else you notice. What did you find out? Does temperature or light matter?

biodome

Send it to ZOOM™ Kid's Activity Page

Send pictures of your growing plant to ZOOM, Box 350, Boston, MA 02134

Sent in by Rebecca B. and Anna V. from Longview, TX



ZOOMer result

"I have a suggestion. Plant plants that animals eat. Then put animals (worms, butterflies, caterpillars) in there and watch them grow." Sent in by David via e-mail

MORE STUFF

Plant Race Plant fast-growing seeds, like radishes, in a biodome and in a regular flowerpot. Plant them at the same time and keep them in the same place. Which grows faster? Why?

Sent in by Bena A. from Milton, MA

germinator

There's more to seeds than meets the eye. Every seed has an embryo plant-food for the young plant, and hard coverings to protect it from mold, drought, harsh temperatures, and animals looking for a meal. Seeds even know when conditions are right for germinating (that is, when to begin growing into a plant). The right conditions are the proper amounts of moisture, warmth, and oxygen. Kids can watch seeds grow by creating a germinator in a plastic bag. Because they'll be controlling the conditions, they find out what plants need to start growing.

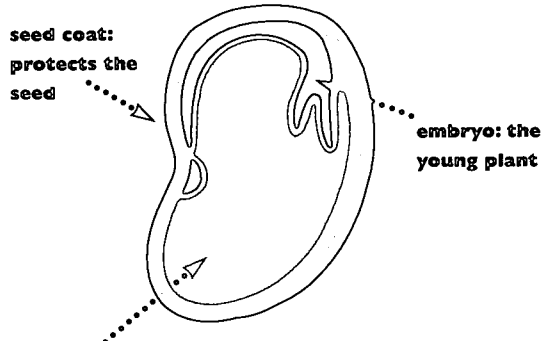
1 Mess Around

When kids make their germinator, they'll see seeds develop roots and sprouts. To show them where these roots and sprouts come from, try this warmup activity.

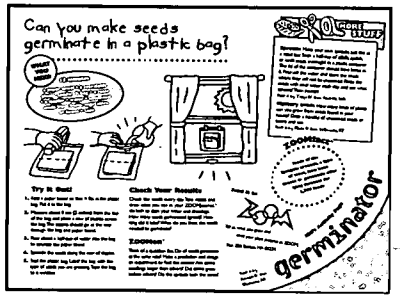
For each kid you'll need a few lima beans, a hand lens, a paper cup, and water. Have kids soak their lima beans for 24 hours. After soaking the seeds, kids should be able to carefully split the lima beans in half and examine their insides. Have them use the hand lens to get a better look. Can they find the plant embryo? Ask them to draw what they see in their ZOOMjournals.

The Science Scoop

Three Common Parts of a Seed



2 Try It Out!



Read the activity instructions for Germinator on page 27 before starting.

Materials (for each kid) a paper towel ∘ a resealable plastic sandwich bag ∘ a ruler ∘ a stapler ∘ water ∘ uncooked seeds from fruits, vegetables, or beans ∘ tape

Activity Preparation Remind kids to save and bring in seeds from uncooked fruits and vegetables that they have eaten.

Try It Out! Before setting up the germinators, ask kids to describe what conditions they think seeds require to germinate. Make sure the kids label their bags with the type of seed(s).

Check Your Results Over time, kids can observe and record the growth of the seeds. Which seeds grew the most? How much did they grow? They can draw pictures in their ZOOMjournals.

ZOOMon One experiment kids could do is this: Make another germination bag with different types of seeds. Check the seeds every day to see if they germinate at different rates. Have the kids take notes and draw pictures of their observations in their ZOOMjournals. Which seeds grew at the same rate? Did they look different?

The Science Scoop Can you make seeds germinate in a plastic bag? Because the activity asks kids to tape their germinator to a window, they may conclude that light is a requirement for germination. But it isn't. Ask them to think about where germination usually occurs—in soil where it is dark.

Most seeds need only three things to germinate: water, oxygen, and a comfortable temperature. If the seeds are healthy, at least some of them should germinate. (Chlorine in tap water can sometimes affect germination, so you may want to use bottled or distilled water. Also, if you do this activity in the wintertime, the windowpane may be too cold for seeds to germinate. Just put them in a light, warm place.)

3 More Stuff

Keep kids' interest growing with these additional challenges listed on the Kid's Activity Page. Here are some tips and hints.

Sprouts Keep the sprouts moist by rinsing them twice a day, but not so wet that mold grows. Make sure the lid of the sprouting jar has adequate holes to allow air in. Alfalfa sprouts should be ready to eat in a week or so. Because sprouts contain all the food the young plants need to start growing, they are highly nutritious and packed with vitamins.

Mystery Seeds Kids can find all kinds of seeds around their house, such as fresh fruits and vegetables or beans. First, they can germinate the seeds in a plastic bag, then plant them in soil.

RESOURCES

Books

Cohen, Joy, and Eve Pranis. *Grow Lab Activities for Growing Minds.* Burlington, VT: National Gardening Association, 1990. Hands-on science activities that use plants to bring science to life.

Imes, Rick. *The Practical Botanist.* New York: Simon and Schuster/Fireside, 1990. A comprehensive introduction to the world of plants, including some hands-on activities.

Web Sites

The Great Plant Escape
http://www.aces.uiuc.edu/uplink/gpe/gpe.html
Plant biology activities.

Ms. Grow-It-All
http://www.homearts.com/depts/garden/gro010f2.htm
Great gardening projects for kids.

Organizations

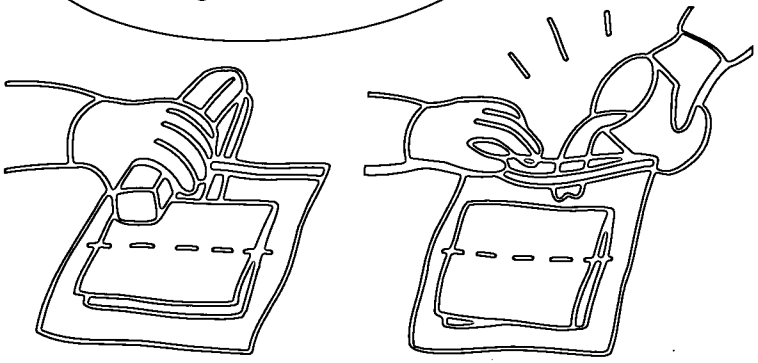
Grow Your Own Tree, National Arbor Day Foundation, 211 North 12th Street, Lincoln, NE 68508. Membership benefits ($10 membership) include 10 seedlings to plant, newsletters, information on national programs for kids, and educational materials.

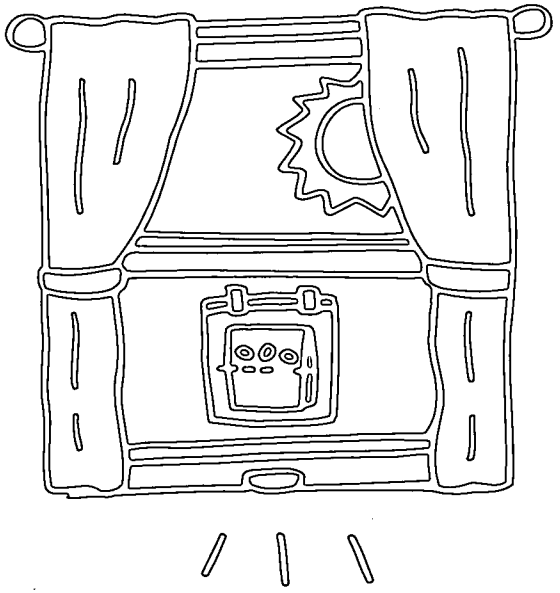
Can you make seeds germinate in a plastic bag?

WHAT YOU NEED

15 minutes

a paper towel ○ a resealable plastic sandwich bag ○ a ruler ○ a stapler ○ water ○ uncooked seeds from fruits, vegetables, or beans ○ tape





Try It Out!

1. Fold a paper towel so that it fits in the plastic bag. Put it in the bag.
2. Measure about 8 cm (3 inches) from the top of the bag and place a row of staples across the bag. The staples should go all the way through the bag and paper towel.
3. Pour about a half-cup of water into the bag to saturate the paper towel.
4. Sprinkle the seeds along the row of staples.
5. Seal the plastic bag. Label the bag with the type of seeds you are growing. Tape the bag to a window.

Check Your Results

Check the seeds every day. Take notes and draw what you see in your ZOOMjournal.™ Be sure to date your notes and drawings. How many seeds germinated (grew)? How long did it take? What do you think the seeds needed to germinate?

ZOOMon™

Think of a question like, Do all seeds germinate at the same rate? Make a prediction and design an experiment to find the answer. Are some seedlings larger than others? Did some grow before others? Do the sprouts look the same?

MORE STUFF

Sprouts Make your own sprouts, just like at a salad bar. Soak a half-cup of alfalfa, radish, or lentil seeds overnight in a plastic container. The lid of the container should have holes in it. Pour off the water and store the seeds where they will not be disturbed. Rinse the seeds with cool water each day and see what sprouts! Then munch!

Sent in by Tanya M. from Seattle, WA

Mystery Seeds How many kinds of plants can you grow from seeds found in your house? Grab a handful of uncooked seeds or beans and see.

Sent in by Chris F. from Willmantk, CT

ZOOMfact™

Seeds of the Spergula arvensis, a type of weed, have been known to germinate after lying dormant for 1,700 years.

Send it to

ZOOM™

Tell us what you grew and send your plant pictures to ZOOM, Box 350, Boston, MA 02134.

Sent in by Amanda H. from Sherwood, AR

Kid's Activity Page

germinator

count and observe

Birds startle easily and fly away in the blink of an eye. Just when kids want to get a closer look at them, with a flap of their wings they're off into the wild blue yonder. That's where bird feeders come in handy. Bird feeders give birds a reason to hang around, and then kids get a chance to check them out. This simple bird feeder provides kids with an opportunity to observe and identify many common birds. Kids can begin by looking for simple features such as color, size, and shape. Later they might want to observe behavior and song or call.

1 Mess Around

Not all birds eat the same food—even those that visit bird feeders. Different types of food attract different kinds of birds.

Tell kids they are going to make a bird feeder but need to decide what type of food local birds eat. Use a bird field guide or library books to help them find out what kinds of birds live in your area. Use the information from the chart in the Science Scoop to help them decide what type(s) of food they should use to attract specific birds.

The Science Scoop

Birds' Favorite Menus

Black-oil and striped sunflower seeds
most birds

White proso millet
finches, sparrows

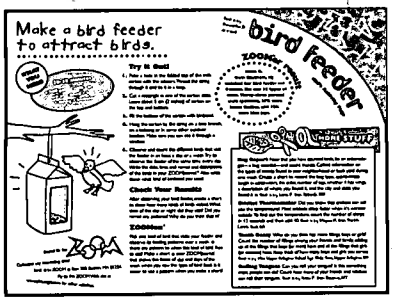
Shelled peanuts
jays, titmice, woodpeckers

Thistle seed
goldfinches, siskins

Chick scratch
quails, doves

Suet (use only in cold weather)
chickadees, nuthatches, woodpeckers

Try It Out!



Read the activity instructions for Bird Feeder on page 30 before starting.

Materials (for each kid) a half-gallon milk carton, rinsed and dried • scissors • string • birdseed (the types that birds in your area eat)

Try It Out! Birds have a hard time refusing a free lunch. So regardless of your location, kids should get birds at their feeders. Decide how often kids should observe the site (for example, twice a day for a week), whatever works for them. Once the feeders are assembled, have kids take them home and hang them outside. (If some kids do not have a place to hang the feeders at home, have them hang them near your location and check from there.) Remind kids that they need to be able to see the feeders to make observations and record data. Also tell them to be patient. It may take time for birds to visit the feeder. Stress to kids the importance of continuing to feed the birds, since they come to depend on it.

Check Your Results Discuss kids' bird-watching observations. Have kids make charts to represent their data. One kind of chart is a grid with times of day on the vertical axis and days of the week on the horizontal axis. Record the number of birds observed as numerals (see sample chart in next column). Did they see more of one bird than another? Were some birds found at different times of day? Ask them what their data tells them, but also ask them to think about what their data *doesn't* tell them.

ZOOMon After the observation period is over, have kids present their results and charts.

NUMBER OF BIRDS BY DAY

TIME OF DAY	S	M	T	W	Th	F	S
8 am							
10 am							
12 noon							
2 pm							
4 pm							

The Science Scoop Will different birds visit the bird feeder at different times of day? Birds usually follow a routine, feeding and bathing at the same time of day. Different species have different schedules, so kids should see a variety of birds coming and going at different but fairly predictable times.

3 More Stuff

Try these challenges to keep kids observing nature and collecting data. (See the Kid's Activity Page for the actual challenge.) Here are some things to consider.

Bug Report After kids record the bug information, have them find a way to organize it. They could make lists or charts based on the bugs' attributes. Encourage them to analyze their data the way they did in the main activity.

Cricket Thermometer There are a number of factors that can skew the results including your geographic location, the number and types of cricket species in your area, the time of day, and the season. Also, some crickets chirp in self-defense, so there may be more chirps if the crickets feel threatened. Check your results against a real thermometer.

Tooth Decay Finding averages is an important part of analyzing the data collected. Kids should find the average number of fillings. They can do this by dividing the number of cavities by the number of subjects. They could average across different subgroups (males, females, old, young, etc.), as well as doing an overall average.

Rolling Tongues Suggest that kids chart this data according to factors such as age or gender. Then ask them to look for patterns and draw conclusions about who can roll their tongues.

RESOURCES

Books

Crook, Beverly Courtney. *Invite a Bird to Dinner.* New York: Lothrop, Lee & Shepard, 1978. Contains instructions for making a variety of simple bird feeders and bird foods.

Forshaw, Joseph, Steve Howell, Terence Lindsey, and Rich Stallcup. *Birding.* Time Life Books, 1995. An illustrated guide to birds and birding; includes maps, resources, and tips for locating and identifying birds in North America.

Web Sites

Audubon News
http://www.audubon.org/
Information on land and wildlife conservation, and bird-watching from the National Audubon Society.

Birdsource Website
http://birdsource.cornell.edu/
Data collection activities on birds, including their migratory and feeding habits. Also cool facts about different kinds of bird.

Birdwatching Dot Com
http://www.birdwatching.com
Lots of tips, stories, and access to bird-watching videos, tapes, books, and CD-ROMs.

Organizations

Project Feeder Watch
The Laboratory of Ornithology at Cornell University, 156 Sapsucker Woods Road, Ithaca, NY 14850. From November to March, Cornell University runs a feeder watch for all of North America. Participants record the species that visit their feeders each week and send the data to Cornell, where it is collated and used to study fluctuations in species populations.

Make a bird feeder to attract birds.

Sent in by Samantha D. via e-mail

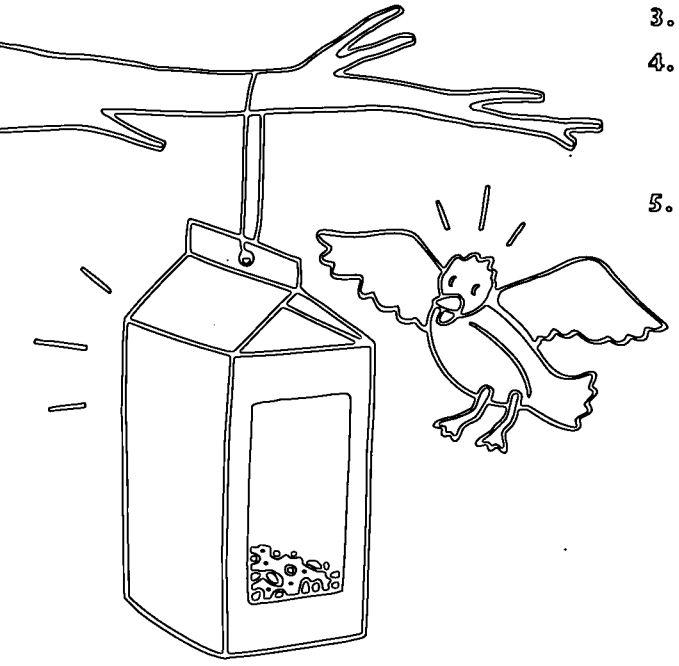
bird feeder

Kid's Activity Page

WHAT YOU NEED

20–30 minutes

a half-gallon milk carton, rinsed and dried ○ scissors ○ string ○ birdseed



Try It Out!

1. Poke a hole in the folded top of the milk carton with the scissors. Thread the string through it and tie it in a loop.
2. Cut a rectangle in one of the carton sides. Leave about 5 cm (2 inches) of carton on the top and bottom.
3. Fill the bottom of the carton with birdseed.
4. Hang the carton by the string on a tree branch, on a balcony, or in some other outdoor location. Make sure you can see it through a window.
5. Observe and count the different birds that visit the feeder in an hour, a day, or a week. Try to observe the feeder at the same time every day. Write the date, time, and names and descriptions of the birds in your ZOOMjournal.™ Also write down what kind of birdseed you used.

Check Your Results

After observing your bird feeder, create a chart to show how many kinds of birds visited. What time of the day or night did they visit? Did you notice any patterns? Why do you think that is?

ZOOMon™

Pick one kind of bird that visits your feeder and observe its feeding patterns over a week. Is there any pattern to when this kind of bird likes to eat? Make a chart in your ZOOMjournal that shows the times of day and days of the week when you saw this type of bird feed. Is it easier to see a pattern when you make a chart?

ZOOMer™ result

Katie D. from Chatham, NJ watched her bird feeder for 2 weeks. She saw 12 types of birds. Thirty-three percent were sparrows, 27% were house finches, and 12% were blue jays.

Send it to ZOOM™

Collected any interesting data?

Send it to ZOOM at Box 350, Boston, MA 02134.

Fly to the ZOOM Web site at www.pbs.org/zoom for other activities.

MORE STUFF

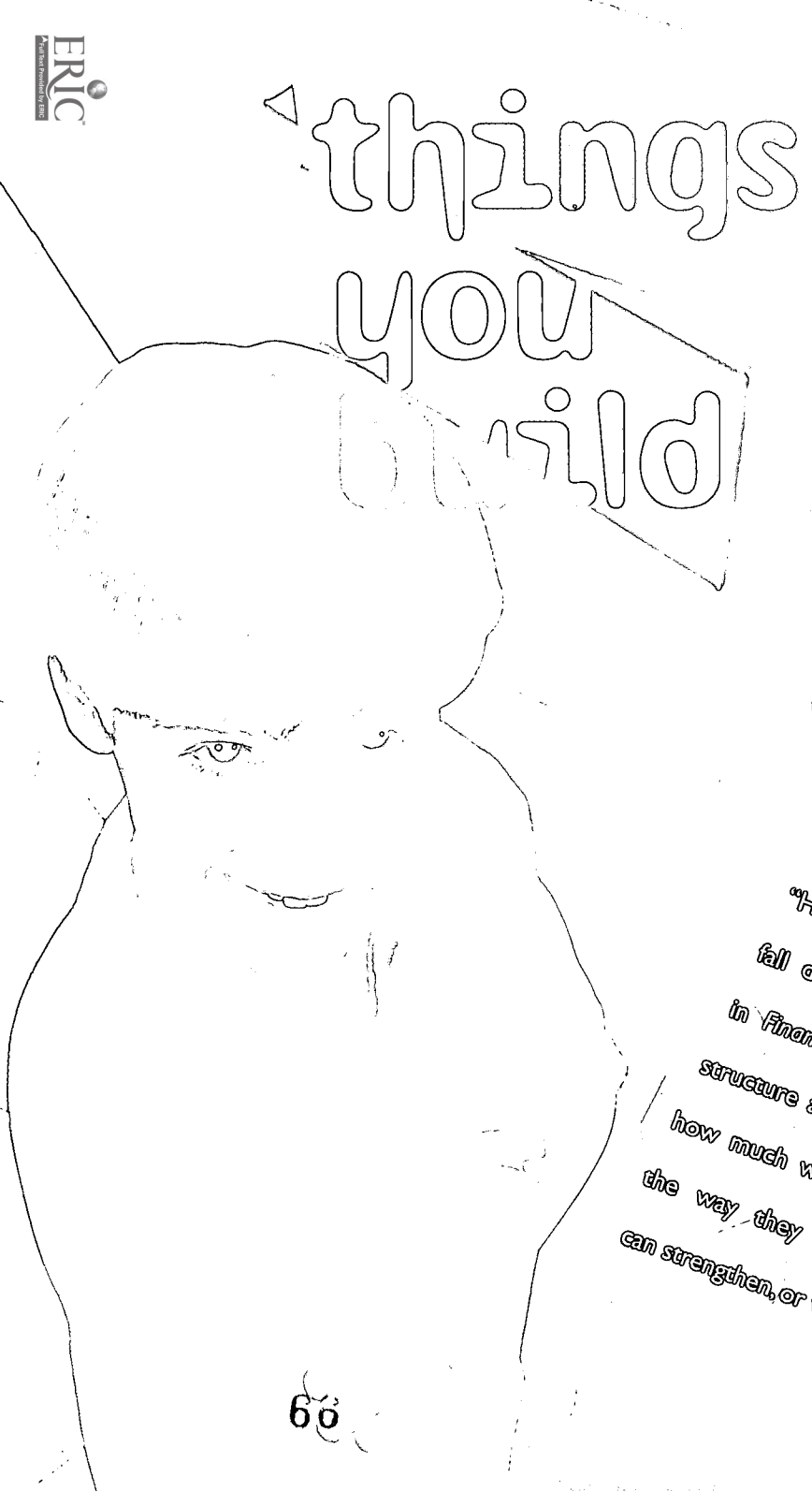
Bug Report Now that you have counted birds, be an entomologist—a bug scientist—and count insects. Collect information on the types of insects found in your neighborhood or back yard during one week. Create a chart to record the bug type, approximate length in centimeters, the color, number of legs, whether it has wings, a description of where you found it, and the city and state you found it in. Sent in by Aaron F. from Kirksville, MO

Cricket Thermometer Did you know that crickets can tell you the temperature? Most crickets chirp faster when it's warmer outside. To find out the temperature, count the number of chirps in 13 seconds and then add 40. Sent in by Megann H. from North Little Rock, AR

Tooth Decay Who do you think has more fillings, boys or girls? Count the number of fillings among your friends and family, adding up all the fillings that boys (or men) have and all the fillings that girls (or women) have. Keep track of how many boys and girls you survey. Sent in by the Upper Arlington School Age Child Care, Upper Arlington, OH

Rolling Tongues Can you roll your tongue? Is this something most people can do? Count how many of your friends and relatives can roll their tongues. Sent in by Aaron F. from Bozeman, MT

things you build



What generates more suspense than a wobbly stack of dominoes that teeters and sways the higher it climbs? Kids combine building with balancing in *Upside Down Mobile* while exploring the relationship between balance and height.

Things really take off as kids build a parachute to explore gravity and air resistance and how these forces can protect or destroy a structure. They design a *Parachute* to deliver a delicate cargo—a raw egg—to Earth safely. No flights of fancy here. It can be done—and no doubt the kids will find many imaginative ways to do it.

"How high will it go?" and "What will make it fall down?" Kids have a chance to find out in *Financial Support* as they build as tall a structure as possible and experiment with how much weight it can support. Along the way, they consider how shapes can strengthen, or weaken, a structure.

height

Think about all the balancing that kids do: they learn to stand, walk, ride seesaws and bikes, and do handstands and cartwheels. So, if nothing else, kids have a physical sense of what balance is. Some kids have explored balance by experimenting on the playground. Many a parent has sat on a seesaw while two or three kids climbed on the other side and tried to make the seesaw balance. What happens if the parent moves toward the center of the seesaw? The kids at the other end seem heavier! But we all know they are not. This is the phenomenon that kids work with to achieve height in a unique upside-down mobile.

Mess Around

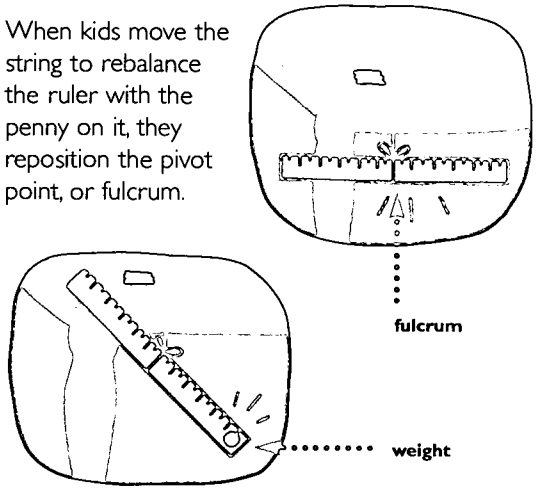
Start out by messing around with balance. You'll need a 12-inch ruler, a penny, tape, and a two-foot piece of light string for each kid.

Pass out the materials, except for the pennies. Tell the kids to tie one end of the string around the ruler and tie or tape the other end to a table edge or other object so that the ruler hangs down. The ruler should hang on its edge rather than flat because it's easier to find the balancing point in this position. The knot should be at the top edge of the ruler. Ask the kids to experiment with changing the location of the string until the ruler balances.

Now pass out the pennies. Tell kids to tape a penny to the printed side of the ruler, centering it between the 11-inch and 12-inch marks, and let the ruler hang. Ask them to predict where they should move the string to balance the ruler now. See if they can come up with a rule. Experiment over and over with changing the location of the penny and string until the ruler balances. Does the rule work? Kids can also add different numbers of pennies at different places to test for balance.

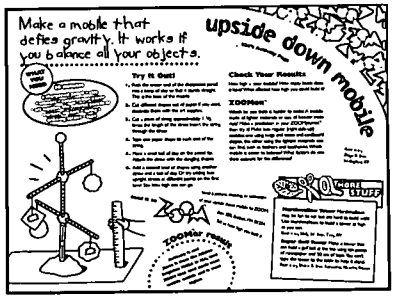
The Science Scoop The first time around kids will probably find that the ruler balances at roughly the 6-inch mark. This balance point is the center of gravity. It's a mathematical point where the weight seems to be centered. When they add the penny between the 11-inch and 12-inch marks, the center of gravity shifts to about the 7-inch mark. (This may vary depending on the weight of the ruler.)

When kids move the string to rebalance the ruler with the penny on it, they reposition the pivot point, or fulcrum.



The closer the fulcrum is to a weight, the easier it is to lift that weight. Think back to the seesaw. When the parent moved forward, he or she seemed lighter. If the parent moves close enough to the fulcrum, the kids may be able to lift him or her. Encourage kids to draw on this experience when they make their mobiles.

2 Try It Out!



Read activity instructions for Upside Down Mobile on page 34 before starting.

Materials (for each pair) a sharpened pencil ∘ clay ∘ scissors ∘ construction paper ∘ art supplies, like colored pencils or markers, stickers ∘ string ∘ drinking straws ∘ tape

Activity Preparation You'll need sturdy tables or desks on which kids can build their mobiles.

Try It Out! It can be tricky to get the various levels of the mobile to balance. It's easier if kids have partners to help, so divide the group into pairs.

Check Your Results How many levels did their mobiles have? Ask what kids did to make them balance? Why do kids think they worked?

ZOOMon Kids will probably find that the mobiles made of lighter materials were harder to balance than the ones made of heavier materials. A light object jostles easily, whereas a heavier object responds less to the jolts of the building process. The weight of the object actually helps stabilize it. This makes it easier for kids to handle the mobile and to test for its center of gravity.

The Science Scoop How high can the kids' upside-down mobiles go? Kids should discover that their mobiles are delicate and tipsy. If the base of the mobile is sturdy and straight, and if they build the mobile carefully, they should be able to go up two—possibly three—levels. It's unlikely that any mobiles will exceed three levels. In addition to the difficulty of balancing the structure, there is the problem of the weight of clay needed to bind the mobile. Eventually the levels become too heavy for the structure to support. Mobiles are really nothing more than a series of levers. To keep the levers stable, kids need to balance unequal forces. They do this by adjusting the balancing, or pivot, points.

3 More Stuff

Keep kids in balance with these activities listed on the Kid's Activity Page. Here are some tips and hints.

Marshmallow Tower Because a single column of marshmallows will most likely fall down before it gets very tall, the most effective structure to build is a pyramid. Kids will need to moisten or cut off the marshmallow ends to make them stick together.

Super Golf Tower Encourage kids to use columns, which are among the strongest structural shapes. These supporting columns need to be secured to something, but they cannot be taped directly to the table or floor, so kids should secure them to a foundation sheet.

RESOURCES

Books

Lipman, Jean, with Margaret Aspinwall. *Alexander Calder and His Magical Mobiles*. New York: Hudson Hills Press in association with the Whitney Museum of American Art, 1981. Contains examples of mobile art by Alexander Calder.

Smith, Howard E., Jr. *Balance It!* New York: Four Winds Press, 1982. Contains exercises and projects that explore the principles of balance and center of gravity.

Web Sites

Mobiles that Fly!
http://www.onenorthpole.com/ToyShop/Mobiles.html
Contains instructions for building regular hanging mobiles from clothes hangers.

Finding the Center of Gravity
http://teams.lacoe.edu/documentation/classrooms/judi/activities/gravity.html
An activity for experimenting with the center of gravity.

Make a mobile that defies gravity. It works if you balance all your objects.

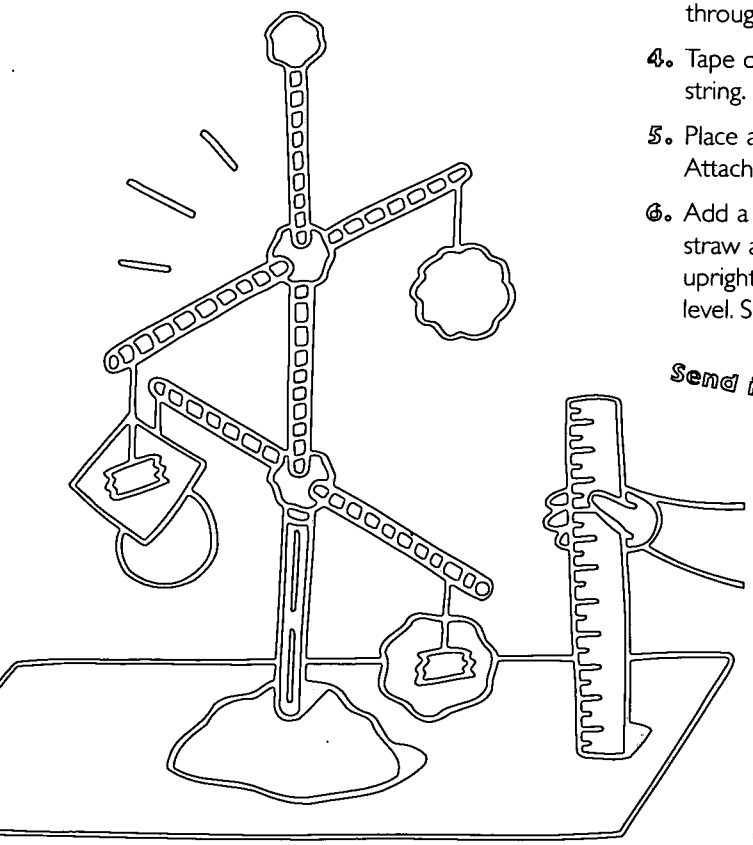
upside down mobile

Kid's Activity Page

WHAT YOU NEED

30 minutes

a sharpened pencil ○ clay ○ scissors ○ construction paper ○ art supplies, like colored pencils or markers, stickers ○ string ○ drinking straws ○ tape



Try It Out!

1. Push the eraser end of the sharpened pencil into a lump of clay so that it stands straight. This is the base of the mobile.
2. Cut different shapes out of paper. If you want, decorate them with the art supplies.
3. Cut a piece of string approximately 1 1/2 times the length of the straw. Insert the string through the straw.
4. Tape one paper shape to each end of the string.
5. Place a small ball of clay on the pencil tip. Attach the straw with the dangling shapes.
6. Add a second level of shapes using another straw and a ball of clay. Or try adding two upright straws at different points on the first level. See how high you can go.

Check Your Results

How high is your mobile? How many levels does it have? What affected how high you could build it?

ZOOMon™

Which do you think is harder to make: A mobile made of lighter materials or one of heavier materials? Make a prediction in your ZOOMjournal,™ then try it! Make two regular (right-side-up) mobiles: one using twigs and twine and cardboard shapes, the other using the lightest materials you can find, such as feathers and toothpicks. Which mobile is easier to balance? What factors do you think account for the difference?

Sent in by Diego S. from Wallingford, CT

Send it to

Send a picture, drawing, or videotape of your upside down mobile to ZOOM,™ Box 350, Boston, MA 02134. Tell us how high you built it.

ZOOMer result™

Anthony V. and Jason S. from the Allston Brighton YMCA in MA, told ZOOM that they made their mobile smaller and it went higher.

MORE STUFF

Marshmallow Tower Marshmallows may be fun to eat but are hard to build with! Use marshmallows to build a tower as high as you can.

Sent in by Molly W. from Troy, NY

Super Golf Tower Make a tower that can hold a golf ball at the top using ten pieces of newspaper and 50 cm of tape. You can't tape the tower to the table to help it stand.

Sent in by Matt B. from Edmonton, Alberta, Canada

protection

Many of our greatest inventions are designed to work with or against forces. Some of these inventions are structures used to protect us from forces like gravity. Consider the rubber soles on sneakers—they protect our feet by decreasing the impact when we run and jump. Parachutes are another structure used for protection. In this activity, kids work with the force of air resistance to design a parachute to protect its "passenger"—a raw egg—from the force of gravity.

Mess Around

Are you ready to *eggsplore* air resistance? You'll need two sheets of paper and a chair that's safe to stand on for each pair of kids.

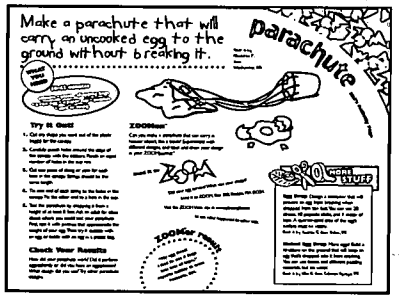
Divide the group into pairs. Tell the kids that one person in each pair will be "mission control," and the other will be the paper dropper. Give the droppers two sheets of paper. Have them crumple one sheet of paper and leave the other flat. Ask kids to predict whether the crumpled or the flat piece of paper will hit the floor first. Ask for the reasons behind their predictions.

Now, have the droppers stand up on the chair and drop the two sheets of paper at the same time. Their partners count down "ready, set, go" before the sheets drop.

Ask kids to revisit their predictions. How close were they? Ask kids to come up with different shapes of paper to test? Keep messing around.

The Science Scoop The flat sheet of paper falls more slowly than the crumpled sheet because of air resistance. The force of gravity pulls both to the ground, but because the flat sheet has a larger exposed surface area, it descends more slowly. Ask kids if they can think of inventions that use air resistance. Examples might include kites, sailboats, and, of course, parachutes.

2 Try It Out!



Read activity instructions for Parachute on page 37 before starting.

Materials (for each pair) scissors • plastic shopping bags • a raw egg • a paper cup • pennies • yarn or string

Activity Preparation After making the parachutes, kids need to drop them from a height of eight feet or more. Try to find an outdoor location from which kids can drop the parachutes because of the possibility of messy *eggsplosions*. If none is available, you can place the eggs in sealed plastic bags.

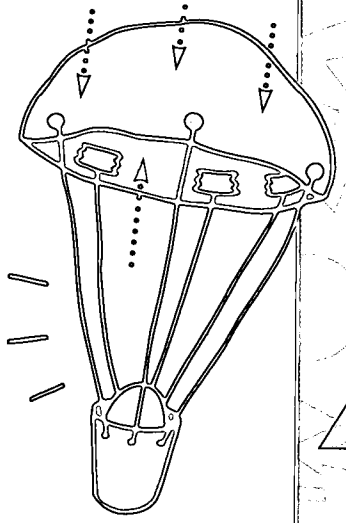
Try It Out! Before making their parachutes, have kids talk in pairs about which design will work best. Then have them make their design. They can write explanations of their designs and make sketches in their ZOOMjournals. Encourage kids to try different shapes and sizes and test them with pennies before they make their final parachutes. This type of challenge requires lots of trial and error. Kids should feel that they can try different designs.

Check Your Results Discuss which designs delivered the egg safely and why.

ZOOMon Suggest that kids do a little research for this challenge, such as reading books about parachutes or even visiting a kite shop. In order to make a canopy strong enough to carry a book, they'll need a very large and strong trash bag or fabric, or a combination of these materials. They'll also need strong twine to hold the book. Emphasize safety when exploring locations to test their parachutes.

The Science Scoop

What design elements help the parachute safely carry an egg to the ground?



air pushes up against the falling parachute creating drag

The larger the surface area of an object, the greater the air resistance it encounters as it falls. This air resistance is called drag. The part of a parachute that causes drag is the canopy. If kids make bigger canopies, the parachutes should descend more slowly. The shape of the canopy affects the surface area. Shapes like triangles and stars don't have as much surface area as circles and squares. The number of strings connecting the canopy to the cup affects the shape of the canopy. More strings create a more domed or boxed shape, which usually results in a slower descent. Kids might also cut and tape the canopy materials together for an even more three-dimensional shape and slower descent.

RESOURCES

Books

Morgan, Sally, with Adrian Morgan. *Structures*. New York: Facts on File, 1994. Examines a variety of manufactured structures, from skyscrapers to airplanes, and discusses how they imitate natural structures like eggs and seedpods in protecting and transporting living beings.

Paananen, Eloise. *Parachutes: How They Work*. New York: Putnam, 1972. In kid terms, explains the principles behind how parachutes work

Web Sites

American Museum of Natural History
http://www.amnh.org/mars/eggdrop.html
An interesting approach to an egg-drop activity, which uses the landing of the Mars exploration craft *Pathfinder* as a model for using airbags to break the fall of a landing object.

3 More Stuff

Challenge kids to build these protective structures. (The actual challenge is on the Kid's Activity Page.) Here are some tips and hints.

Egg Drop There are a number of ways to solve this challenge. One way is to "crate" the egg in the popsicle sticks; placing the straws on the outside absorbs the most impact because they are hollow.

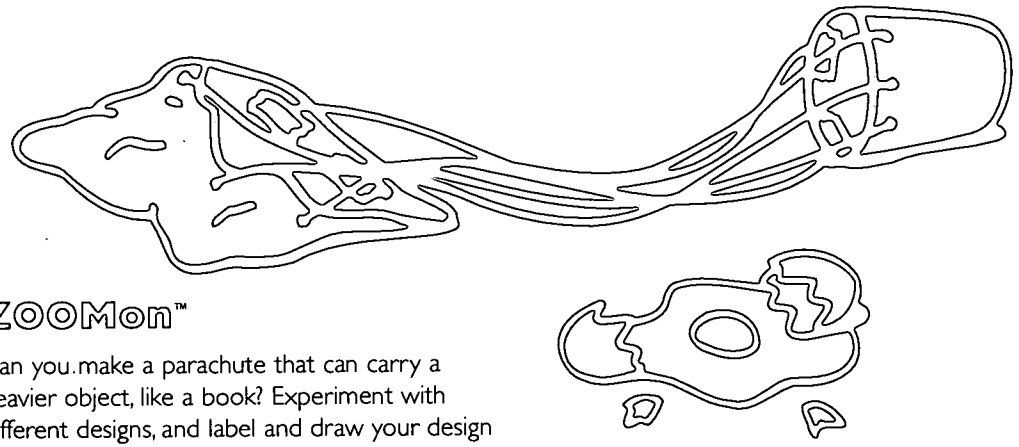
Naked Egg Drop Encourage kids to experiment with materials that cushion the egg when it lands such as foam, cotton balls, or loosely crumpled newspaper.

Parachute

Kid's Activity Page

Make a parachute that will carry an uncooked egg to the ground without breaking it.

Sent in by
Christian F.
from
Winchester, MA



WHAT YOU NEED

30–45 minutes

scissors ○ plastic shopping bags ○ a raw egg ○ a paper cup ○ pennies ○ yarn or string

Try It Out!

1. Cut any shape you want out of the plastic bag(s) for the canopy.
2. Carefully punch holes around the edge of the canopy with the scissors. Punch an equal number of holes in the cup rim.
3. Cut one piece of string or yarn for each hole in the canopy. Strings should be the same length.
4. Tie one end of each string to the holes in the canopy. Tie the other end to a hole in the cup.
5. Test the parachute by dropping it from a height of at least 8 feet. Ask an adult for ideas about where you could test your parachute. First, test it with pennies that approximate the weight of your egg. Then try it outside with an egg, or inside with an egg in a plastic bag.

Check Your Results

How did your parachute work? Did it perform eggscellently or did you have an eggsplosion? What design did you use? Try other parachute designs.

ZOOMon™

Can you make a parachute that can carry a heavier object, like a book? Experiment with different designs, and label and draw your design in your ZOOMjournal.™

Send it to ZOOM™

Did your egg survive? What was your design?

Send it to ZOOM, Box 350, Boston, MA 02134.

Visit the ZOOM Web site at www.pbs.org/zoom

to see what happened to other kids.

ZOOMer result™

"My egg lived! I had to use 4 bags and lots of tape," reports Ashley W. from Fostoria, OH.

MORE STUFF

Egg Drop Design a container that will prevent an egg from breaking when dropped from ten feet. You can use 20 straws, 10 popsicle sticks, and 1 meter of tape. A quarter-sized area of the egg's surface *must* be visible.
Sent in by Andrew C. from Salem, OR

Naked Egg Drop More eggs! Build a structure on the ground that will keep an egg that's dropped into it from cracking. You can use boxes and different padding materials, but no water.
Sent in by Ellen S. from Colorado Springs, CO

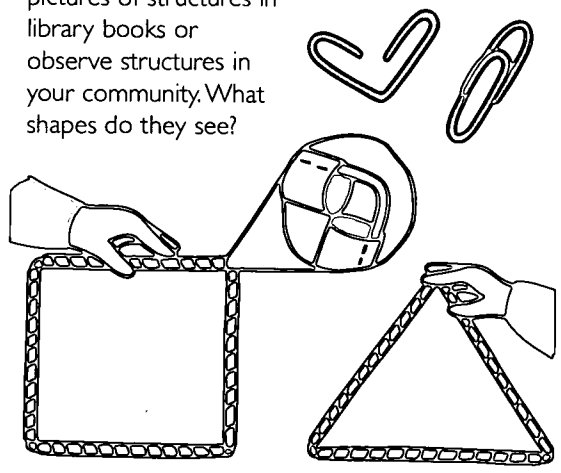
strength

When kids see a skyscraper reaching into the clouds, they might wonder how so tall a structure can stand. They might also wonder why a bridge doesn't just collapse from the weight of cars. The secret of any structure's strength is the way it balances loads and forces. In this activity, kids explore how much weight a straws-and-clay tower can hold.

Mess Around

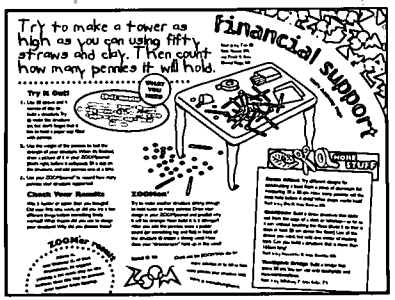
Kids can test which shapes are the strongest with this activity.

Pass out ten plastic drinking straws and ten paper clips to each kid. Tell them to open the paper clips and use them as joiners. Then ask them to make a triangle and a square out of straws and paper clips. Kids can cut the straws into smaller pieces if they choose. Tell kids to stand each shape on its side and press down on it. What happens? How do the square and triangle differ? Show kids pictures of structures in library books or observe structures in your community. What shapes do they see?



The Science Scoop Triangles are strong and tend to retain their shape even when pushed or pulled because all three sides of the triangle are connected. When you put weight on any corner of a triangle the other two corners try to pull together, but can't because the opposite side pushes them apart. Squares are weaker; when you put weight on a corner, they collapse. However, putting a cross beam on the square creates two triangles, making it stronger.

2 Try It Out!



Read activity instructions for Financial Support on page 40 before starting.

Materials (for each pair) construction paper ∘ 50 plastic drinking straws ∘ 4 oz. modeling clay ∘ paper or plastic cup ∘ lots of pennies

Activity Preparation You will need sturdy tables or desks on which the kids can build their structures.

Try It Out! Because this is an open-ended challenge, there are many different approaches kids can take. Remind them to keep experimenting if they don't succeed the first time. They can always take the straws and clay apart. Have the kids work in pairs so they can share strategies.

Check Your Results Ask: What was most challenging about building the structures? What was easy?

ZOOMon Ask the kids to think about what they could change to make their structures hold more pennies. What shapes did they use? What other shapes could they try? Have them draw their new, improved designs in their ZOOMjournals, label the changes, and predict the results. Then discuss how their changes worked.

The Science Scoop How tall a structure can you make with fifty straws and a handful of clay? There are a number of ways in which the kids can approach this challenge. Straws are circular columns that can bear a lot of weight. To achieve height, kids could pinch the ends of straws and insert them into other straws to make longer columns. These columns could then be reinforced with other straws as corner braces, using clay as "mortar." Kids could use bundled straws as thick columns, or they could use the straws and clay to make a series of stacked trusses, like those used in truss bridges (bridges made by joining triangles).

3 More Stuff

Keep kids ZOOMing with these activities listed on the Kid's Activity Page. Here are some tips and hints.

Boats Afloat The best boat shape is the one that covers the largest possible area on the water's surface (a flat sheet). The weight of the pennies needs to be evenly distributed on the boat so that it does not sink.

Cantilever One way to offset gravity is to create a pull in the opposite direction. This can be done by hanging the cantilever from a "rope" made of tape and straws. Attach this rope to a tower built either vertically from the edge of the table or angled toward the center of the table. Have the kids think of other solutions.

Toothpick Bridge The force of things pushing together is called compression. It can be used to hold things up. Kids need to figure out how to use compression to balance gravity's pull on the center of the bridge. Encourage them to explore arched shapes, which distribute the bridge's weight down its legs to the ground and prevent it from collapsing.

RESOURCES

Books

Brown, David J. *The Random House Book of How Things Were Built.* New York: Random House, 1992. An illustrated history of more than sixty notable structures of the ancient and modern world. Includes detailed diagrams and a glossary of architectural terms.

Zubrowski, Bernie. *Messing Around with Drinking Straw Construction.* Boston: Little, Brown, 1981. Contains projects using straws and other common materials to explore structural engineering issues such as strength and stability.

Web Sites

The Amazing Straw/Pin Motion Toy
http://elaine.teleport.com/~tommiles/motoyht.html
Has a great structural engineering project using straws and pins to make a flexible three-dimensional motion toy, which changes shape as you move its edges. See how many different shapes you can make!

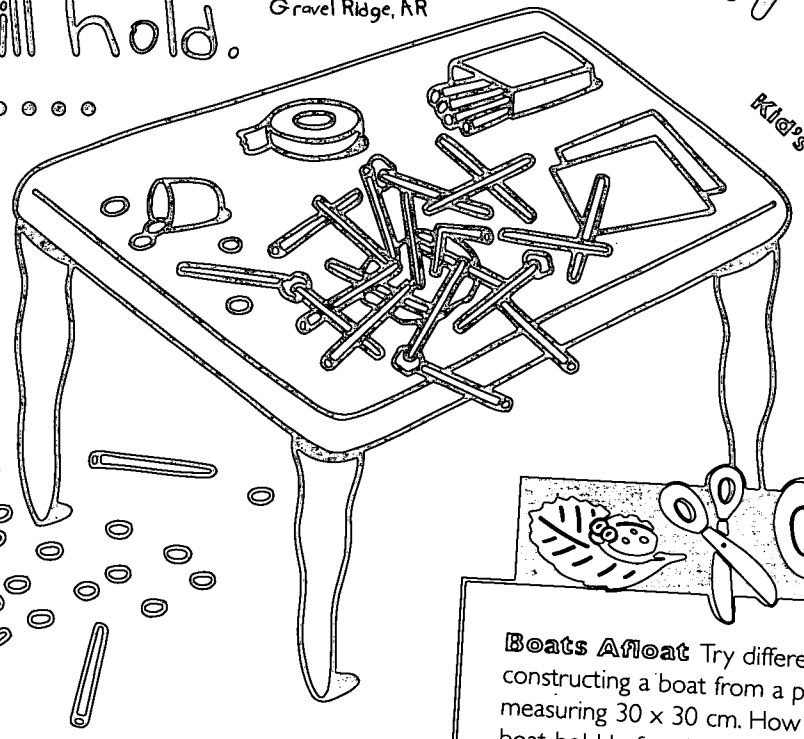
Straws and Pins—Building Up
http://netra.exploratorium.edu/scale/straws.html
A page for educators to explore building structures from drinking straws and pins (or paper clips) with kids.

Financial Support

Kid's Activity Page

Try to make a tower as high as you can using fifty straws and clay. Then count how many pennies it will hold.

Sent in by Tom G. from Revere, MA, and Frank S. from Gravel Ridge, AR



Try It Out!

WHAT YOU NEED

20–45 minutes • construction paper • 50 plastic drinking straws • 4 oz. modeling clay • paper or plastic cup • lots of pennies

1. Use 50 straws and 4 ounces of clay to build a structure. Try to make the structure tall, but don't forget that it has to hold a paper cup filled with pennies.
2. Use the weight of the pennies to test the strength of your structure. When it's finished, draw a picture of it in your ZOOMjournal (that's right, before it collapses). Sit a cup on the structure, and add pennies one at a time.
3. Use your ZOOMjournal™ to record how many pennies your structure supported.

Check Your Results

Was it harder or easier than you thought? Did your first idea work, or did you try a few different things before something finally worked? What shapes did you use to design your structure? Why did you choose those?

ZOOMer™ result

Alison K. and Whitney K. of East Providence, RI suggest putting a lot more clay on the bottom than the top to prevent your tower from tipping.

ZOOMon™

Try to make another structure strong enough to hold twice as many pennies. Draw your design in your ZOOMjournal and predict why it will be stronger. Now build it. Is it stronger? After you add the pennies, wave a poster board (or something big and flat) in front of the structure to create a strong wind. How does your "strawscraper" hold up in the wind?

Send it to

ZOOM™

Check out the ZOOM Web site for more activities or to tell us how many pennies your structure held. We're at www.pbs.org/zoom.

MORE STUFF

Boats Afloat Try different designs for constructing a boat from a piece of aluminum foil measuring 30 x 30 cm. How many pennies will the boat hold before it sinks? What shape works best?
Sent in by Dan H. from Boston, MA

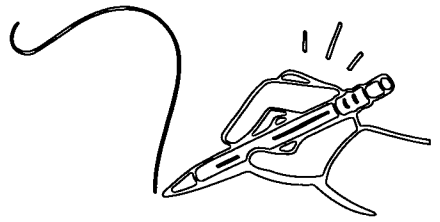
Cantilever Build a straw structure that sticks out from the edge of a desk or tabletop—as far as it can without touching the floor. (Build it so that it stays at least 55 cm above the floor.) Use all the straws you want, but only one meter of masking tape. Can you build a structure that is more than 165cm long?
Sent in by Samantha R. from Brookline, MA

Toothpick Bridge Build a bridge that spans 50 cm. You can use only toothpicks and mini-marshmallows.
Sent in by Whitney F. from Keller, TX

ZOOM journal

Name

Activity



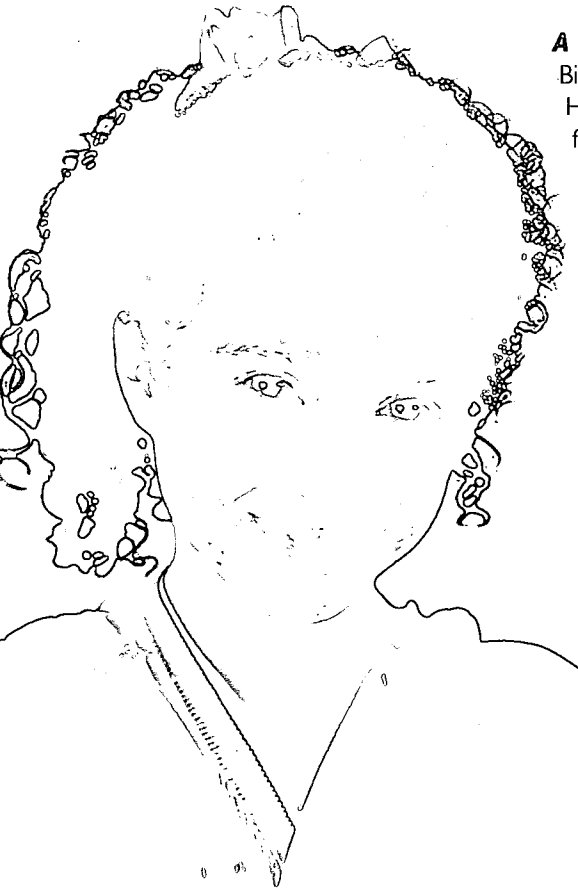
Draw Here

Your Prediction

Results

more resources

Books



A Kid's Guide to Building Forts
Birdseye, Tom. Tucson, AZ: Harbinger House, 1993. Presents a brief history of forts, step-by-step instructions for building indoor and outdoor forts, hints on where to obtain materials, and safety tips.

Building: From Caves to Skyscrapers
Salvadori, Mario. New York: Atheneum, 1979. Introduces basic principles governing the design of buildings, bridges, and more, using models made of common materials.

The Cartoon Guide to Physics
Gonick, Larry, and Art Huffman. New York: HarperCollins, 1990. Presents a range of physics concepts in an accessible cartoon format.

Domes: A Project Book
MacGregor, Anne, and Scott MacGregor. New York: Lothrop, Lee & Shepard, 1981. Explores the history and structure of domes from ancient times to the present. Includes instructions for building model domes.

Flight through the Ages
Gibbs-Smith, C.H. New York: Thomas Y. Crowell, 1974. An illustrated survey of the history of flight, from early history to the present.

The Hidden World of Forces
White, Jack R. New York: G.P. Putnam's Sons, 1987. Discusses some of the forces at work in the universe, such as electromagnetism, gravitation, surface tension, and friction, with illustrative experiments.

The Kingfisher Science Encyclopedia
Headlam, Catherine, ed. New York: Kingfisher Books, 1993. Presents articles on scientific and technological topics arranged in alphabetical order.

Machines
Baker, Wendy, and Andrew Haslam. New York: Thomson Learning, 1994. Contains instructions for making various simple machines.

Physics for Every Kid
VanCleave, Janice. New York: John Wiley & Sons, 1991. An introduction to physics for kids.

Understanding Structures and Materials
Kerrod, Robin. Morristown, NJ: Silver Burdett, 1986. Describes some of the world's natural materials such as minerals, synthetics such as plastics, and the aesthetic and functional uses to which they have been put, particularly in the construction of buildings and bridges.

The Way Things Work
Macaulay, David. Boston: Houghton Mifflin, 1988. An illustrated guide to the principles and workings of hundreds of machines.

Web Sites

Biology4Kids
http://www.chem4kids.com/biology4kids/index.html
Sections on key topics in biology, such as cells and the chemistry of biology, and a quiz.

Exploratorium
http://netra.exploratorium.edu/
Web site of the Exploratorium: A fantastic museum of science, art, and human perception located in San Francisco. Check out the Digital Library, or visit the Learning Studio.

How Things Work
http://erwin.phys.virginia.edu/Education/Teaching/HowThingsWork/
Lets you send your physics questions and get them answered by a university professor.

The Knowledge Adventure Encyclopedia
http://letsfindout.com/
Gives you access to all kinds of cool information on a variety of topics, plus links to other cool sites.

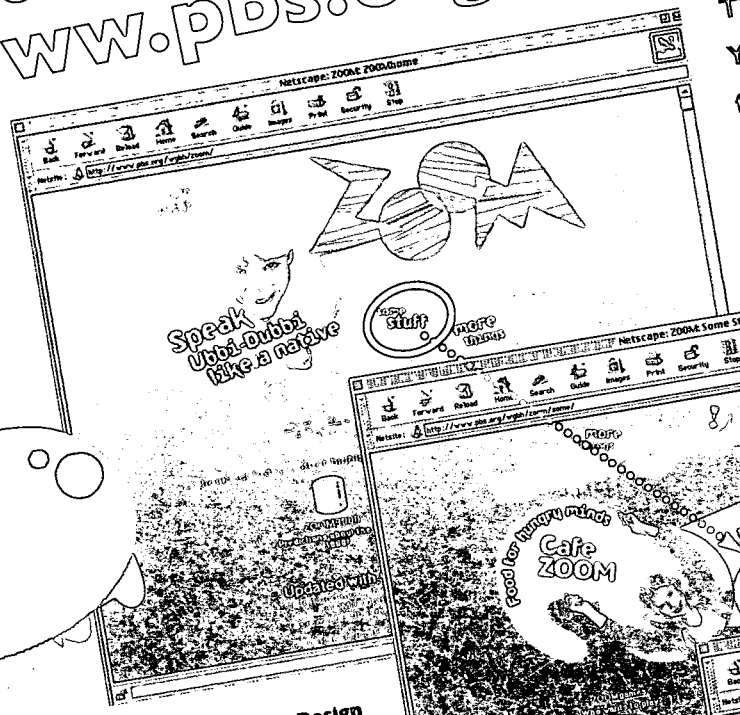
Mad Scientist Network
http://www.madsci.org/
Features the MadSci Library for finding science resources on the web, as well as "Ask-A-Scientist," which lets you search thousands of archived files or use the Random Knowledge Generator.

Physics4Kids
http://www.chem4kids.com/physics4kids/index.html
Sections on forces, motion, thermodynamics, light, and electricity, as well as a quiz.

Usenet Physics FAQ
http://erwin.phys.virginia.edu/Education/Teaching/HowThingsWork/resources.html
A good place to start looking for answers to your questions about physics.

Where to find ZOOMsci...

www.pbs.org/zoom



The Web site is powered by you. So check it out! You'll find more than 20 of your favorite ZOOM features—and lots more. The ZOOM Web site is updated weekly so there is always something new. Log on if you want to share magnificent ideas with fellow ZOOMers.

ZOOMsci includes:

- **instructions for all the ZOOMsci activities**
- **ideas for further experimentation**
- **results from kids who have tried ZOOMsci experiments**
- **forms to send your results to ZOOM**

Look under "everything else" for Design a Virtual Balloon Car. Download, build, and test drive a Balloon Car with this cooler-than-cool interactive computer model.

TM

web site

All submissions become the property of ZOOM and will be eligible for inclusion in all ZOOMmedia.™ This means that we can share your ideas with other ZOOMers™ on TV, the Web, in print materials, and in other ZOOMways.™ Thanks.

ZOOM™ resources

ZOOM™ zones

ZOOM into a museum near you! Do you want to keep on ZOOMing? Then visit your local science or children's museum! It may have a ZOOMzone—an exhibit space where you can try out even more activities from the show. Even if your museum doesn't have a 'zone, it is full of great exhibits and experiments to keep you ZOOMing. There are ten ZOOMzones across the country, and more are coming soon. To see if there's one in your area, check the ZOOM Web site at www.pbs.org/zoom and look under More Things.

ZOOM Videos and Books

Order Now!

ZOOM Best of the 70s
Delight in video clips from the 1970s' superhot PBS kids' show. 1 hr. $19.95

ZOOMers Revisited: Where Are They Now?
by Pam Benson. This companion book to the video contains interviews with some of the original ZOOMers, 20 years later. There are more than one hundred pages of memories and reflections from some of America's favorite kids of the 1970s. (They're in their forties now!) Softcover book. $14.95

Book and video. $29.95

Coming fall 1999!

ZOOM™ fun with Friends
More than 50 great games, party recipes, and more. For ages 6 to 12.

ZOOM™ zingers
Fifty or more amazing activity challenges from the show. For ages 6 to 12.

Published by Little, Brown

ZOOM™ kits

Order Now!

Share the excitement of ZOOM at home with these interactive kits. Learn about crafts and nature, and have fun! Each kit comes with its own materials to create and learn with as well as a journal kids can use to record their results. For kids ages 8–12. Produced by WGBH/Boston and Woodkrafter Kits. Enjoy all six:

Weather Station $16.95
Wet Pets $16.95
Butterfly Window Feeder $18.95
Make a Nightlight $18.95
Mix 'N Make Natural Soap $16.95
Body Art $18.95

To order any of these products, call or write:
WGBH Boston Video
P.O. Box 2284
South Burlington, VT
05407-2284
1-800-949-8670

All of the games, kits, books, and videos will also be available in stores throughout the country.

Coming summer 1999!

ZOOM™ Games

ZOOM™ out!
A fast-moving card game where kids make the rules—and change them. This highly social game builds logic, sequencing, and matching skills; increases numbers knowledge; and encourages creativity. For kids ages 6 and up. $12.00

ZOOM™ Party
This activity card set includes ZOOM™ zingers, ZOOM™ dos, ZOOM™ funnys, cafeZOOMs,™ and ZOOM™ games. Kids have fun while improving their vocabulary, observational skills, science knowledge, and cooking skills. Perfect for any kids' party or get together. For kids ages 6 and up.

Produced by Gamewright®

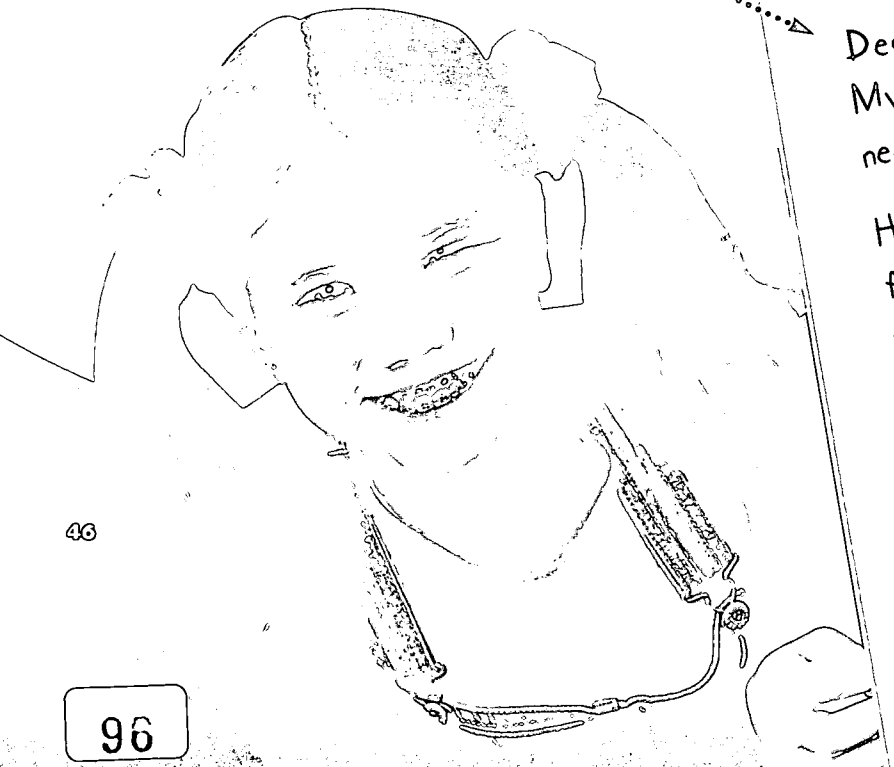
NEW ZOOM

Send us your activities and ideas for...

Solving Problems with Numbers—Tell us how to use numbers to figure problems out and understand information. Liann e-mailed ZOOM this challenge: "You have a pizza and want to cut it into eight pieces, but you can cut the pizza only three times. How do you do it?"

Inventions and Technology—Tell us what you can invent to make your life easier by just using stuff you find around your home. Maxx S. of Whitehall, NY sent ZOOM instructions for making a cereal dispenser.

Waves—Not just the surfing kind. Show us how to do cool things with the waves in sound and light. Mark B. of Los Angeles, CA gave us directions for making a Straw Kazoo.



ZOOM Needs You!

Everything you see on ZOOM
is sent in by kids.
You make the show...
so send it to ZOOM

Dear ZOOM,

My ZOOM sci experiment is called Straw Kazoo. The materials you need are a pair of scissors and a plastic drinking straw.

Here's how you do it: Cut a point at one end of a straw and really flatten the point with your teeth. Blow through the straw and you'll hear it make music.

Here's how you can experiment: Experiment with changing the length of the straw and see if it changes the sound that it makes when you blow.

Try it out on ZOOM!

sent in by Mark B. from Los Angeles, CA

send it to ZOOM™

Fill out this letter like the one for Straw Kazoo and tell ZOOM how to do your cool activity.

Dear ZOOM,

My ZOOMsci activity is:

Here's how you can do it:

Try it out on ZOOM!

sent in by

from

Mail your stuff, along with your name and address, to:

ZOOM
Box 350
Boston, MA
02134

and we'll send you a ZOOMerang—a booklet chock full of cool activities you can see on ZOOM.

You can also log onto www.pbs.org/zoom and post your activities and ideas. You'll find a ZOOMerang™ there that you can download and print out.

All submissions become the property of ZOOM and will be eligible for inclusion in all ZOOMmedia.™ This means that we can share your ideas with other ZOOMers on TV, the Web, in print materials, and in other ZOOMways.™ So, send it to ZOOM! Thanks!

credits

The ZOOMsci Activity Guide was produced by Educational Print and Outreach of the Special Telecommunications Services division, WGBH Educational Foundation.

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ZOOM THEME SONG

Come on you guys
Let's go
Let's do it

ZOOOOOOOM

Come on and ZOOM
Come on and ZOOM
Come on and ZOOM
Come on and ZOOM
Come on and ZOOM
ZOOM ZOOMa ZOOM

ZOOM ZOOM ZOOM

Come on and ZOOM
Come on and ZOOM
Come on and ZOOM
Come on and ZOOM
Come on and ZOOMa
ZOOMa ZOOMa ZOOM

ZOOM ZOOM ZOOM

I'm Zoe
Hey, I'm Jared
ZOOM
I'm Keiko
I'm Pablo
ZOOM ZOOM
I'm Alisa
I'm David
ZOOM
And I'm Lynese

We're all plugged into
one world now

So let's talk
We want to hear from YOU
Come on, give it a try
And if you like what you see
Turn off your TV
And do it

ZOOM ZOOM ZOOM
ZOOM ZOOM

Come on and ZOOM
Come on and ZOOM
Come on and ZOOM
Come on and ZOOM
Come on and ZOOM
ZOOM ZOOMa ZOOM

Come on and ZOOM
Come on and ZOOM
Come on and ZOOM
Come on and ZOOM
Come on and ZOOMa
ZOOMa ZOOMa ZOOM

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SEE IT ON PBS

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